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ABSTRACT

The purpose of this study was to determine whether a process model could be constructed using steps identified from flow charts which accounted for somewhat more variance in predicting the difficulty of two-digit multiplication problems than did a process model developed by Cromer. Cromer's data and variables were used as a starting point. Ten new variables were identified from multiplication and addition flow charts. Seven basic models, 4 reduced models, 10 factor models, 24 one-variable models, and a set of systematic restricted models were examined. Multiple regression analysis was used to predict difficulty. The overall results indicate that the flow chart variables do produce somewhat better models. This volume presents the first of two parts of this report and includes the problem statement and results. (Author/SD)

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TECHNICAL REPORT NO. 337
(PART 1 OF 2 PARTS)

process models for predicting the difficulty of multiplication problems using flow charts

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JULY 1975

WISCONSIN RESEARCH
AND DEVELOPMENT
CENTER FOR
COGNITIVE LEARNING

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Technical Report No. 337 (Part 1 of 2 Parts)

PROCESS MODELS FOR PREDICTING THE DIFFICULTY OF MULTIPLICATION PROBLEMS USING FLOW CHARTS

by

Thomas A. Romberg
Richard Glove

Report from the Project on
Conditions of School Learning and
Instructional Strategies

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ABSTRACT

The purpose of this study was to determine whether a process model could be constructed using steps identified from flow charts which accounted for somewhat more variance in predicting the difficulty of two-digit multiplication problems than did a process model developed by Cromer (1971). Cromer's data and variables were used as a starting point. Ten new variables were identified from multiplication and addition flow charts. Seven basic models, 4 reduced models, 10 factor models, 24 one-variable models, and a set of systematic restricted models were examined. Multiple regression analysis was used to predict difficulty. The overall results indicate that the flow chart variables do produce somewhat better models.

I

THE PROBLEM AND MODELS

INTRODUCTION

While endeavoring to build an adequate theory of mathematics learning, some mathematics educators have attempted to construct and refine theoretical models of mathematics learning confined to specific areas of mathematics. One type of model that has been studied is the process model for the learning of an arithmetic skill.

The purpose of this study was to refine such a model. More work on models needs to be done in order to construct a reasonable theory of mathematics learning which will help teachers to give better instruction to their students in all areas of mathematics.

VARIABLES

Fred Cromer (1971) constructed a model for predicting the difficulty of two-digit by two-digit multiplication problems. In his model, Cromer considered problems of the form

$$\begin{array}{r} ab \\ \times\, cd \\ \hline \end{array}$$

where a, b, c, and d are digits, with a and c representing the tens digits and b and d the units digits. Any of a, b, c, or d could be equal to 0. If c = 0, the problem was written

$$\begin{array}{r} ab \\ \times\, d \\ \hline \end{array}$$

If a = 0 and c = 0, the problem was written

$$\begin{array}{r} b \\ \times\, d \\ \hline \end{array}$$

No problems of the form

$$\begin{array}{r} b \\ \times\, cd \\ \hline \end{array}$$

were considered, since the students had not had exposure to this type of problem. In attempting to predict the difficulties of these problems, Cromer used 14 variables.

ORD--the order of the problem as presented on the test
TDF--the value of the tens digit of the first number
UDF--the value of the units digit of the first number
TDS--the value of the tens digit of the second number
UDS--the value of the units digit of the second number
OA--the number of operation steps in addition

OA was defined as follows:

$$OA(a + b) = \begin{cases} 0 \text{ if } a = 0 \text{ or } b = 0 \\ 1 \text{ otherwise} \end{cases}$$

$$OA(ab + d) = \begin{cases} OA(b + d) \text{ if } b + d \leq 9 \\ OA(b + d) + 1 \text{ if } b + d > 9 \end{cases}$$

$$OA(ab + cd) = \begin{cases} OA(b + d) + 1 \text{ if } b + d \leq 9 \\ OA(b + d) + 2 \text{ if } b + d > 9 \end{cases}$$

$$OA(abc + def) = OA(a + d) + OA(bc + ef) + K$$

$$\text{where } K = \begin{cases} 0 \text{ if } bc + ef \leq 99 \\ 1 \text{ if } bc + ef > 99 \end{cases}$$

$$OA(abcd + efgh) = OA(a + e) + OA(bcd + fgh) + K$$

$$\text{where } K = \begin{cases} 0 \text{ if } bcd + fgh \leq 999 \\ 1 \text{ if } bcd + fgh > 999 \end{cases}$$

OM--the number of operation steps in multiplication

OM was defined as follows:

$$OM(a \times b) = \begin{cases} 0 \text{ if } a \text{ or } b \text{ equals } 0 \text{ or } 1 \\ 1 \text{ otherwise} \end{cases}$$

$$OM(ab \times c) = OM(a \times b) + OM(b \times c) + K$$

$$\text{where } K = \begin{cases} 0 \text{ if } b \times c \leq 9 \\ 1 \text{ if } b \times c > 9 \end{cases}$$

$$OM(ab \times cd) = OM(ab \times c) + OM(ab \times d)$$

DCA--the number of digits carried in addition

DCA was defined as follows:

$$DCA(abcd + efgh) = K_1 + K_2 + K_3$$

where

$$K_1 = \begin{cases} 0 \text{ if } d + h \leq 9 \\ 1 \text{ if } d + h > 9 \end{cases}$$

$$K_2 = \begin{cases} 0 \text{ if } cd + gh \leq 99 \\ 1 \text{ if } cd + gh > 99 \end{cases}$$

$$K_3 = \begin{cases} 0 \text{ if } bcd + fgh \leq 999 \\ 1 \text{ if } bcd + fgh > 999 \end{cases}$$

DCM--the number of digits carried in multiplication

DCM was defined as follows:

$$DCM(ab \times cd) = \begin{cases} 0 \text{ if } b \times d \leq 9 \text{ and } b \times c \leq 9 \\ 1 \text{ if } b \times d > 9 \text{ or } b \times c > 9 \text{ but not both} \\ 2 \text{ if } b \times d > 9 \text{ and } b \times c > 9 \end{cases}$$

LDF--the largest digit in the factors
SDF--the smallest digit in the factors
NDP--the number of digits in the product
SMD--a variable to indicate whether the units and tens digits of either of the factors were the same

$$SMD(ab \times cd) = \begin{cases} 0 \text{ if } a \neq b \text{ and } c \neq d \\ 1 \text{ if } a = b \text{ or } c = d \end{cases}$$

LFS--a variable to indicate whether the second factor was larger than the first factor

$$LFS(ab \times cd) = \begin{cases} 0 \text{ if } ab < cd \\ 1 \text{ if } ab \geq cd \end{cases}$$

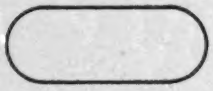
As the dependent variable, Cromer used a variable for the general problem difficulty (DIFF). He determined the value for this variable by administering two forms of an 84-problem multiplication test to 238 fifth-grade students. The problems were determined by using a random number routine. DIFF was defined to be the proportion of the students who failed to arrive at the correct solution. Thus, the lower the value of DIFF, the less difficult the problem was. The range of DIFF could be 0 to 1.

The purpose of this study was to consider several variations of Cromer's model that could be achieved by replacing some of his variables with other variables in the hope of arriving at a better prediction model. Thus, using Cromer's data as a basis, new models were constructed. Cromer's variables OM and OA failed to differentiate adequately between different types of problems. For example, the following problems all have OM = 2, using Cromer's definition:

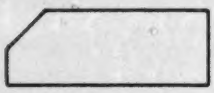
42	40	61	82	15
x 2	x34	x55	x41	x20

A flow chart description of algorithms by Romberg and Anglin (1973) appeared to differentiate between more different classes of problems. The flow chart indicating the various steps that were involved in completing the multiplication part of a multiplication problem is shown in Figure 1.

In the diagram:



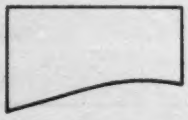
indicates that the procedure stops, starts, or goes to a different routine



information is entered into the procedure

a decision is made in the procedure

an operation is performed; something is computed or calculated



something is written

Because the different types of steps may differentially influence difficulty, it was decided to count the number of decisions made, the number of calculations done, and the number of writing operations involved in each problem, as well as the number of total steps needed to complete the routine. Therefore, the following variables were considered:

NDM--the number of decisions that an individual would have to make when going through the multiplication routine
YDM--the number of those decisions to which the answer yes was given
NOM--the number of operational steps that were involved in the multiplication routine
NWM--the number of writing steps in the multiplication routine
TSM--the total number of steps in the multiplication routine

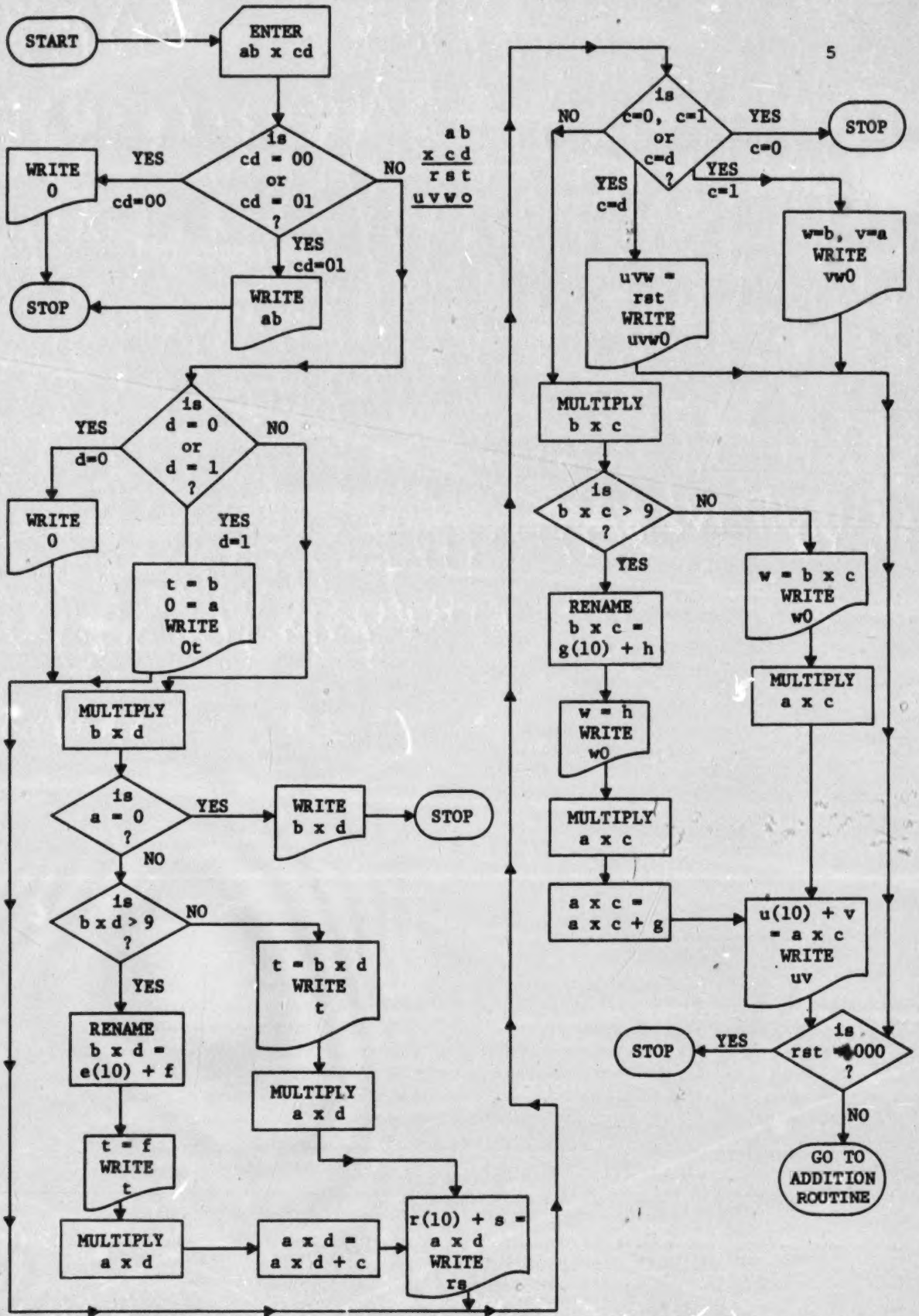


Figure 1. Flow chart for the multiplication part of a multiplication problem.

So, for the problems indicated above, where Cromer's variable CM = 2, the values for these new variables are:

	42 x 2	40 x34	61 x55	82 x41	15 x20
NDM =	5	7	6	5	5
YDM =	1	0	1	1	3
NOM =	2	4	2	2	4
NWM =	2	4	3	3	3
TSM =	9	15	11	10	12

It should be noted that NDM + NOM + TSM. The other types of steps involved in the routine were not considered, since their values would not have differed for the problems considered and since the problems were already printed for the student to read and use.

Similarly, a flow chart was constructed for the addition part of a multiplication problem (see Figure 2). The following variables were defined for the addition routine.

NDA--the number of decisions that an individual would have to make when going through the addition routine
YDA--the number of those decisions to which the answer yes was given
NOA--the number of operational steps that were involved in the addition routine
NWA--the number of writing steps in the addition routine
TSA--the total number of steps in the addition routine

Here also, NDA + NOA + NWA = TSA.

The values of these 10 new variables and the values of Cromer's 15 variables for all 168 problems are given in Table 58 in Appendix A.

MODELS

Since a slightly different statistical package was available on the Univac 1110 at the University of Wisconsin-Madison from the one Cromer used, his original models were also re-evaluated so that comparisons could be made using the same procedure. The REGAN 2 program for multiple linear regression analysis (1971) was used to evaluate the models. The models examined fit into five categories: basic models, reduced models, factor models, one-variable models, and restricted models.

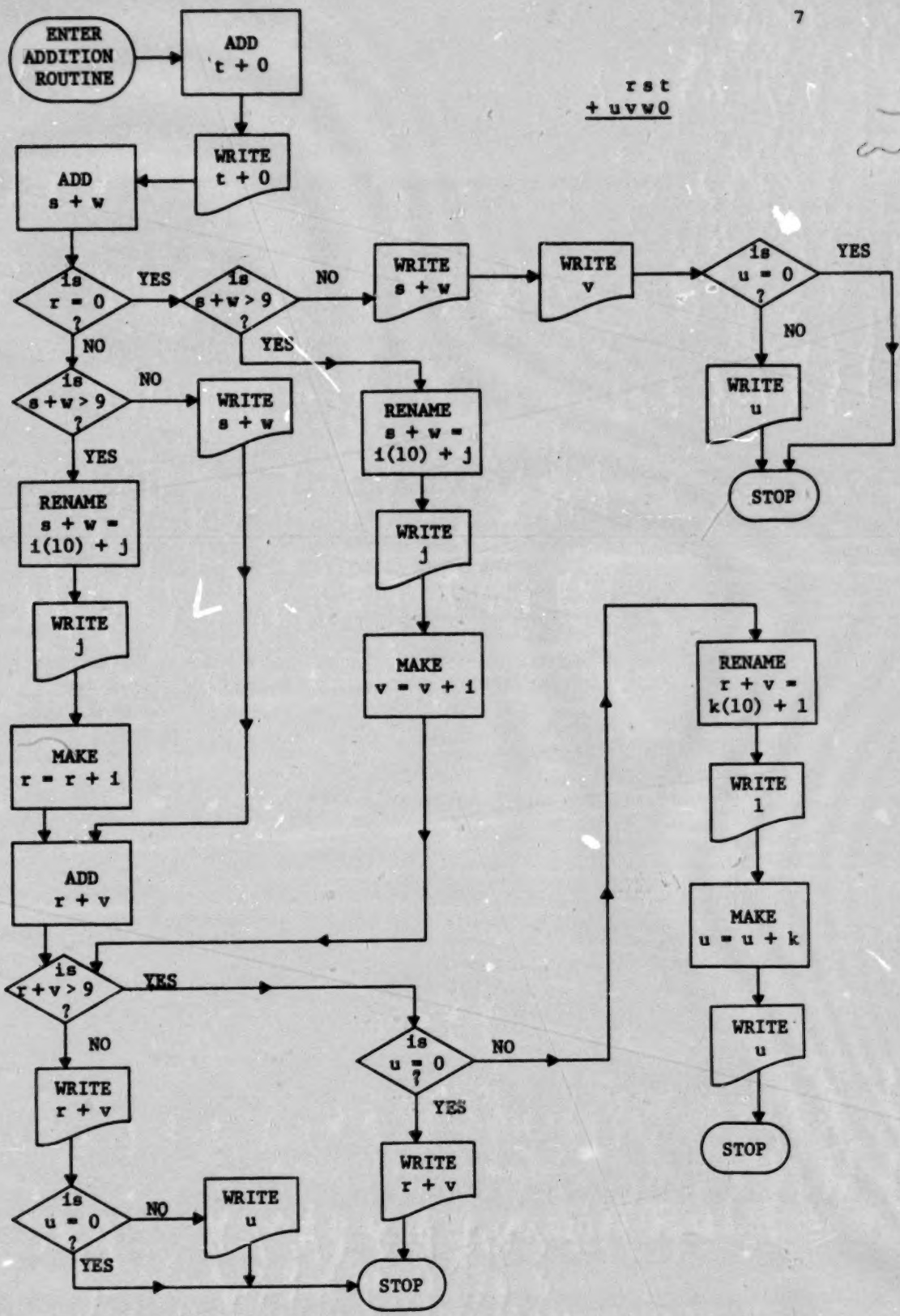


Figure 2. Addition flow chart.

Basic Models

Model 1 (the complete Cromer model) consists of all of Cromer's 14 variables used as predictors.

$$DIFF = A_0 + A_1\ ORD + A_2 \cdot TDF + A_3 \cdot UDF + A_4 \cdot TDS + A_5 \cdot UDS + A_{16} \cdot OA + A_{17} \cdot OM + A_{18} \cdot DCA + A_{19} \cdot DCM + A_{20} \cdot LDF + A_{21} \cdot SDF + A_{22} \cdot NDP + A_{23} \cdot SMD + A_{24} \cdot LFS + E_1 \quad (1)$$

E_1 is the error in the model and the A_is were to be determined by the multiple regression procedure.

Model 2 (the Cromer digit model) was constructed using the 4 Cromer digit variables (TDF, UDF, TDS, and UDS) to see how it compared with Model 1.

$$DIFF = A_0 + A_2 \cdot TDF + A_3 \cdot UDF + A_4 \cdot TDS + A_5 \cdot UDS + E_2 \quad (2)$$

where E_2 is the error in the model.

Model 3 (the Cromer process model) used the 9 process variables (OA, OM, DCA, DCM, LDF, SDF, NDP, SMD, and LFS) and was also compared with Model 1.

$$DIFF = A_0 + A_{16} \cdot OA + A_{17} \cdot OM + A_{18} \cdot DCA + A_{19} \cdot DCM + A_{20} \cdot LDF + A_{21} \cdot SDF + A_{22} \cdot NDP + A_{23} \cdot SMD + A_{24} \cdot LFS + E_3 \quad (3)$$

Model 4 (the flow chart complete model) was constructed using the 10 new variables along with the 14 Cromer variables except OA and OM. This model was then compared with Model 1 to see if it accounted for more of the variance in the difficulty level.

$$DIFF = A_0 + A_1 \cdot ORD + A_2 \cdot TDF + A_3 \cdot UDF + A_4 \cdot TDS + A_5 \cdot UDS + A_6 \cdot NDM + A_7 \cdot YDM + A_8 \cdot NOM + A_9 \cdot NWM + A_{10} \cdot TSM + A_{11} \cdot NDA + A_{12} \cdot YDA + A_{13} \cdot NOA + A_{14} \cdot NWA + A_{15} \cdot TSA + A_{18} \cdot DCS + A_{19} \cdot DCM + A_{20} \cdot LDF + A_{21} \cdot SDF + A_{22} \cdot NDP + A_{23} \cdot SMD + A_{24} \cdot LFS + E_4 \quad (4)$$

Model 5 (the flow chart--process model) used the 10 new variables with the 9 Cromer process variables except OA and OM. This model was compared with Models 1, 3, and 4.

$$\begin{aligned} DIFF = {} & A_0 + A_6 \cdot NDM + A_7 \cdot YDM + A_8 \cdot NOM + A_9 \cdot NWM + A_{10} \cdot \\ & TSM + A_{11} \cdot NDA + A_{12} \cdot YDA + A_{13} \cdot NOA + A_{14} \cdot NWA + \\ & A_{15} \cdot TSA + A_{18} \cdot DCA + A_{19} \cdot DCM + A_{20} \cdot LDF + A_{21} \cdot \\ & SDF + A_{22} \cdot NDP + A_{23} \cdot SMD + A_{24} \cdot LFS + E_5 \end{aligned} \quad (5)$$

Model 6 (the flow chart only model) was designed to see how much of the variance was accounted for by the 10 new factors. It was then compared with Models 1, 3, 4, and 5.

$$\begin{aligned} DIFF = {} & A_0 + A_6 \cdot NDM + A_7 \cdot YDM + A_8 \cdot NOM + A_9 \cdot NWM + A_{10} \cdot \\ & TSM + A_{11} \cdot NDA + A_{12} \cdot YDA + A_{13} \cdot NOA + A_{14} \cdot NWA + A_{15} \cdot \\ & TSA + E_6 \end{aligned} \quad (6)$$

Model 7 (the flow chart--digit model) used the 10 new variables along with Cromer's 4 digit variables. It was compared with Models 1, 4, and 6.

$$\begin{aligned} DIFF = {} & A_0 + A_2 \cdot TDF + A_3 \cdot UDF + A_4 \cdot TDS + A_5 \cdot UDS + A_6 \cdot \\ & NDM + A_7 \cdot YDM + A_8 \cdot NOM + A_9 \cdot NWM + A_{10} \cdot TSM + A_{11} \cdot \\ & NDA + A_{12} \cdot YDA + A_{13} \cdot NOA + A_{14} \cdot NWA + A_{15} \cdot TSA + E_7 \end{aligned} \quad (7)$$

Reduced Models

Since the number of steps of each type involved in both the multiplication and addition routines is partly determined by the number of digits carried in multiplication (DCM) and addition (DCA), it was decided to consider 2 models that deleted the two variables DCM and DCA.

Model 8 (reduced Model 5) was constructed using the 10 new variables and the Cromer process variables except OA, OM, DCA, and DCM. This model was compared with Models 3, 5, and 6.

$$\begin{aligned} DIFF = {} & A_0 + A_6 \cdot NDM + A_7 \cdot YDM + A_8 \cdot NOM + A_9 \cdot NWM + \\ & A_{10} \cdot TSM + A_{11} \cdot NDA + A_{12} \cdot YDA + A_{13} \cdot NOA + \\ & A_{14} \cdot NWA + A_{15} \cdot TSA + A_{20} \cdot LDF + A_{21} \cdot SDF + A_{22} \cdot \\ & NDP + A_{23} \cdot SMD + A_{24} \cdot LFS + E_8 \end{aligned} \quad (8)$$

Model 9 (reduced Model 4) used the 10 new variables, the 4 Cromer digit variables and the Cromer process variables except OA, OM, DCA, and DCM. This model was compared with Models 1, 4, 7, and 8.

$$\begin{aligned} DIFF = {} & A_0 + A_2 \cdot TDF + A_3 \cdot UDF + A_4 \cdot TDS + A_5 \cdot UDS + A_6 \cdot \\ & NDM + A_7 \cdot YDM + A_8 \cdot NOM + A_9 \cdot NWM + A_{10} \cdot TSM + \\ & A_{11} \cdot NDA + A_{12} \cdot YDA + A_{13} \cdot NOA + A_{14} \cdot NWA + A_{15} \cdot \\ & TSA + A_{20} \cdot LDF + A_{21} \cdot SDF + A_{22} \cdot NDP + A_{23} \cdot SMD + \\ & A_{24} \cdot LFS + E_9 \end{aligned} \tag{9}$$

Also, Cromer included the variable SMD, which equals 1 if the tens digit and the units digit of either of the factors are equal. Otherwise, the value of SMD equals 0. It would be expected that this factor would correlate negatively with the difficulty (in Cromer's study it does, in fact). However, the only case in which the digits' being the same would be an important consideration is when the units and the tens digits of the second factor are the same, thus allowing the student to only actually do one multiplication. In the case where the units and tens digits of the first factor are the same, it would not affect the problem so much. Since the multiplication routine considers this possibility, it was decided to construct two additional models deleting SMD.

Model 10 (reduced process model) was constructed using the 10 new variables and the Cromer process variables LDF, SDF, NDP, and LFS. This model was compared with Models 3, 5, 6, and 8.

$$\begin{aligned} DIFF = {} & A_0 + A_6 \cdot NDM + A_7 \cdot YDM + A_8 \cdot NOM + A_9 \cdot NWM + \\ & A_{10} \cdot TSM + A_{11} \cdot NDA + A_{12} \cdot YDA + A_{13} \cdot NOA + A_{14} \cdot \\ & NWA + A_{15} \cdot TSA + A_{20} \cdot LDF + A_{21} \cdot SDF + A_{22} \cdot NDP + \\ & A_{24} \cdot LFS + E_{10} \end{aligned} \tag{10}$$

Model 11 (reduced complete model) used the 10 new variables Cromer's digit variables, and the Cromer process variables LDF, SDF, NDP, and LFS. This model was then compared with Models 1, 4, 7, 9, and 10.

$$\begin{aligned} DIFF = {} & A_0 + A_2 \cdot TDF + A_3 \cdot UDF + A_4 \cdot TDS + A_5 \cdot UDS + A_6 \cdot \\ & NDM + A_7 \cdot YDM + A_8 \cdot NOM + A_9 \cdot NWM + A_{10} \cdot TSM + \\ & A_{11} \cdot NDA + A_{12} \cdot YDA + A_{13} \cdot NOA + A_{14} \cdot NWA + A_{15} \cdot \\ & TSA + A_{20} \cdot LDF + A_{21} \cdot SDF + A_{22} \cdot NDP + A_{24} \cdot LFS + \\ & E_{11} \end{aligned} \tag{11}$$

Factor Analytic Models

Since there is considerable correlation between the 24 variables, it was decided to perform a factor analysis, as Cromer had done, of the variables used in all 11 of the models except Model 2. Cromer had used a principle axis factor analysis with promax rotations. The promax rotations yielded oblique factors. These procedures were not available on the Univac 1110 at the University of Wisconsin-Madison, and so a principle factor analysis with verimax rotations was used. Since NDM, NOM, NWM, and TSM are linearly dependent, as are NDA, NOA, NWA, and TSA, and since the principle factor analysis method available could not handle such a situation, TSM and TSA were removed before the factor analysis was performed. The verimax rotations yielded orthogonal factors, and so the results are not comparable with those of Cromer, and in some cases different factors are extracted. The digit variables in Model 2 were not factored, since the numbers were chosen randomly and, therefore, four orthogonal factors could be expected.

One-Variable Models

Since there were 24 predictor variables (Cromer's 14 together with 10 new ones), 24 models consisting of one variable each were considered in order to test the amount of the variation that each variable accounted for.

$$DIFF = A_0 + A_i \cdot W_i + E_{13+i}$$

where W_i = the ith of the 24 possible predictor variables

E_{13+i} = the error of the model

Restricted Models

Next, for each of Models 1-11, systematic restricted models were considered by eliminating one variable from consideration at a time and then replacing that variable and removing the next. This process was continued until all variables had been removed once. This was done to test the independent contribution of each variable.

After the factors were extracted, the variable correlating most highly with that factor was used to construct a new model. Models 1F and 3F-11F, parallel to Models 1 and 3-11, were then constructed and compared with the fast models to see if they accounted for approximately the same amount of the variance. Only factors accounting for more than 1 percent of the total factor variance were included in the analysis. The factors which Cromer extracted from Models 1 and 3 were different from the factors obtained in this study, and therefore two additional models, 1FC and 3FC, were constructed using the factors that he had obtained.

II

RESULTS

In first analyzing the variables for each of the 168 multiplication problems, a correlation matrix was constructed. This matrix was used, with the twenty-fifth row deleted and certain other rows and columns deleted, to perform the factor analysis. The correlation matrix is found in Table 1. All of the variables except ORD and SMD correlated significantly with DIFF. The highest correlation with DIFF was TSM, which accounted for 53 percent of the variance, and the lowest after ORD and SMD was LFS, which accounted for 3 percent. The 10 new variables accounted for a significant part of the variance, with the lowest being YDM and YDA, which accounted for 7.8 percent and 13.2 percent of the variance, respectively.

In this section, the data for the 11 models along with the models derived from the factor analysis are reported. Also, comparisons are made with similar models to note any differences. Data for the one-variable models are summarized.

Model 1. This complete Cromer model produced an R^2 value of .7763 and a corrected R^2 of .7558. The data for Model 1 are presented in Table 2.

When the factor analysis was performed on the variables in Model 1 (13 process and digit variables), 8 factors were extracted. The eighth factor was not considered, since it only accounted for .1 percent of the total factor variance. Table 3 indicates the percentage of the total factor variance and the percentage of the total variance accounted for.

Table 4 presents the rotated factor matrix. Using this table, the variables that correlated most highly with each factor were chosen to represent that factor in the factor model. The variables used were DCM, TDS, DCA, TDF, UDS, LDF, and SMD. The Model 1F generated by the use of these 7 factors is presented in Table 5. This model yielded an R^2 of .7053 and a corrected R^2 of .6924. Since Cromer's factoring procedures yielded oblique factors, the factors that he extracted were somewhat different. Using only 4 factors and the variables DCM, TDS, OA, and TDF to represent them, the model yielded an R^2 of .6572 and a corrected R^2 of .6487. The summary of Model 1FC is presented in Table 6.

In both cases, the models generated from the factors extracted by the factor analysis accounted for less of the variance than did the full model. A summary of the differences in the R^2 for the three models appears in Table 7.

Summaries of the restricted models produced from each of the preceding models are presented in Tables 59, 60, and 61 in Appendix B.

BLE 1

CORRELATION MATRIX
25 FLOW CHART--CROMER VARIABLES

VARIABLE	1 ORD	2 TDF	3 UDF	4 TDS	5 UDS	6 NDM	7 YDM	8 NOM	9 NWM	10 TSM	11 NDA	12 YDA
1 ORD	1.000											
2 TDF	.010	1.000										
3 UDF	.040	-.055	1.000									
4 TDS	-.003	.109	.001	1.000								
5 UDS	.099	-.036	-.022	.031	1.000							
6 NDM	.037	.081	.001	.469	.561	1.000						
7 YDM	.008	-.123	.624	.023	-.125	-.010	1.000					
8 NOM	.044	.055	.415	.413	.470	.791	.363	1.000				
9 NWM	.013	.098	.079	.606	.424	.919	.007	.821	1.000			
10 TSM	.038	.074	.250	.490	.516	.925	.203	.961	.932	1.000		
11 NDA	-.045	.175	.058	.554	.436	.740	-.133	.611	.832	.728	1.000	
12 YDA	-.034	.067	.135	.113	.222	.287	.028	.250	.360	.297	.544	1.000
13 NOA	.000	.286	.181	.444	.504	.675	-.020	.633	.741	.703	.840	.703
14 NWA	-.029	.215	.052	.628	.366	.713	-.136	.599	.821	.710	.972	.480
15 TSA	-.023	.244	.111	.556	.464	.738	-.092	.645	.829	.746	.970	.618
16 OA	.028	.266	.252	.358	.499	.614	.054	.605	.656	.652	.750	.713
17 OM	-.022	.138	.426	.433	.471	.712	.417	.914	.713	.867	.605	.237
18 DCA	.015	.306	.211	.219	.403	.416	.059	.438	.452	.459	.506	.777
19 DCM	.020	.013	.593	.325	.384	.546	.640	.882	.563	.771	.463	.219
20 LDF	.087	.364	.346	.373	.270	.203	.061	.305	.322	.295	.378	.271
21 SDF	-.053	.229	.385	.493	.392	.573	.273	.728	.619	.703	.625	.300
22 NDP	.028	.339	-.003	.693	.271	.733	.070	.573	.774	.693	.691	.265
23 SMD	.021	.039	-.063	.053	.148	-.053	-.001	-.112	-.098	-.098	.083	.150
24 LFS	-.006	-.508	-.073	.564	.126	.233	.031	.203	.305	.244	.234	.079
25 DIFF	.077	.223	.455	.540	.389	.621	.277	.716	.696	.725	.640	.364

VARIABLE	13 NOA	14 NWA	15 TSA	16 OA	17 OM	18 DCA	19 DCM	20 LDF	21 SDF	22 NDP	23 SMD	24 LFS
13 NOA	1.000											
14 NWA	.819	1.000										
15 TSA	.941	.961	1.000									
16 OA	.945	.700	.853	1.000								
17 OM	.668	.605	.660	.658	1.000							
18 DCA	.870	.478	.676	.885	.501	1.000						
19 DCM	.533	.454	.512	.543	.930	.401	1.000					
20 LDF	.414	.373	.410	.428	.322	.374	.287	1.000				
21 SDF	.694	.640	.688	.674	.817	.526	.745	.299	1.000			
22 NDP	.631	.755	.717	.550	.612	.438	.431	.370	.540	1.000		
23 SMD	.135	.079	.108	.146	.066	.160	.042	-.013	.166	-.002	1.000	
24 LFS	.114	.240	.196	.079	.173	-.025	.182	.065	.156	.193	.108	1.000
25 DIFF	.675	.645	.687	.676	.698	.515	.659	.559	.685	.626	-.095	.174

TABLE 2

BASIC REGRESSION STATISTICS
MODEL 1

Variables in the Equation

Variable		Type	Regression Coefficient	Std. Error of Regression Coefficient	Standardized Regression Coefficient	Partial Correlation Coefficient	T-Value with 153 Deg. Freedom	Partial F Value with 1 and 153 Deg. Freedom	Sig. Level
25	DIFF	dependent	----------	----------	----------	----------	----------	----------	-----
		constant	-.1258684	.0379422		-.259	-3.31737	11.00498	.0011
1	ORD	independent	.0001001	.0001699	.0233	.048	.58898	.34690	.5567
2	TDF	independent	.0028766	.0026061	.0726	.089	1.10380	1.21837	.2714
3	UDF	independent	.0094763	.0024531	.2675	.298	3.86304	14.92304	.0002
4	TDS	independent	.0082645	.0029967	.2326	.218	2.75782	7.60558	.0065
5	UDS	independent	.0069716	.0022338	.1871	.245	3.12099	9.74060	.0022
16	OA	independent	.0275044	.0077889	.3724	.275	3.53123	12.46962	.0005
17	OM	independent	-.0143742	.0082202	-.2864	-.140	-1.74864	3.05772	.0824
18	DCA	independent	-.0221403	.0125634	-.1546	-.141	-1.76229	3.10566	.0800
19	DCM	independent	.0347200	.0183226	.2768	.151	1.89493	3.59077	.0600
20	LDF	independent	.0068338	.0041703	.0966	.131	1.63869	2.68529	.1033
21	SDF	independent	.0078841	.0051477	.1242	.123	1.53157	2.34572	.1277
22	NDP	independent	.0331459	.0118151	.2071	.221	2.80539	7.87023	.0057
23	SMD	independent	-.0434748	.0108707	-.1623	-.308	-3.99926	15.99410	.0001
24	LFS	independent	-.0013654	.0146420	-.0064	-.008	-.09326	.00870	.9258

ANALYSIS OF VARIANCE SUMMARY TABLE

Source of Variation	Sum of Squares	Deg. Freedom	Mean Square
Linear Regression	1.40818	14	.10058
Residuals from Regression	.40589	153	.00265
Corrected Total	1.81407	167	

F-Ratio = 37.92 with 14 and 153 Deg. Freedom
Significance Level of F-Ratio = .0000

Correction for Mean	6.74803	1	
Uncorrected Total	8.56210	168	

Standard Error of Estimate..... .0515
Multiple Correlation Coefficient..... .8811
Coefficient of Determination..... .7763
Corrected Coefficient of Determination.... .7558

TABLE 3

PROPORTION OF VARIANCE ACCOUNTED
FOR BY THE FACTORS
MODEL 1

Factor Number	Percentage of Total Factor Variance	Percentage of Total Variance
1	28.0	20.9
2	21.0	15.7
3	17.5	13.1
4	13.1	9.8
5	8.6	6.4
6	7.7	5.7
7	4.1	3.1

TABLE 4

ROTATED FACTOR MATRIX
MODEL 1

Var./Factor		1	2	3	4	5	6	7
1	TDF	-.014	.205	.151	.787	-.024	.187	.056
2	UDF	.679	-.214	.122	-.059	-.239	-.369	.142
3	TDS	.151	.866	.089	-.159	-.087	.194	.101
4	UDS	.198	.024	.271	-.075	.679	.100	.187
5	OA	.347	.250	.773	.091	.239	.167	.186
6	OM	.813	.367	.254	.042	.323	.008	.040
7	DCA	.225	.126	.818	.154	.152	.152	.183
8	DCM	.911	.189	.171	-.076	.196	.073	.007
9	LDF	.167	.247	.207	.151	.124	.675	-.042
10	SDF	.670	.374	.294	.099	.134	.062	.304
11	NDP	.231	.743	.283	.177	.205	.061	.066
12	SMD	.008	.014	.090	-.024	.064	-.021	.368
13	LFS	.025	.445	-.035	-.719	.051	.069	.169

TABLE 5

BASIC REGRESSION STATISTICS
MODEL 1F

Variables in the Equation

Variable	Type	Regression Coefficient	Std. Error of Regression Coefficient	Standardized Regression Coefficient	Partial Correlation Coefficient	T-Value with 160 Deg. Freedom	Partial F Value with 1 and 160 Deg. Freedom	Sig. Level
25 DIFF	dependent	----------	----------	----------	----------	----------	----------	-----
	constant	-.055985	.024691		-.174	-2.26740	5.14111	.0247
19 DCM	independent	.049083	.006430	.3913	.517	7.63333	58.26778	.0000
4 TDS	independent	.010523	.001731	.2962	.433	6.08001	36.96653	.0000
18 DCA	independent	.023777	.007665	.1661	.238	3.10216	9.62340	.0023
2 TDF	independent	.002782	.001937	.0702	.113	1.43656	2.06371	.1528
5 UDS	independent	.005003	.001909	.1342	.203	2.62042	6.86666	.0096
20 LDF	independent	.014848	.003742	.2099	.299	3.96752	15.74118	.0001
23 SMD	independent	-.046499	.011798	-.1736	-.297	-3.94143	15.53490	.0001

Standard Error of Estimate..... .0578
Multiple Correlation Coefficient..... .8398
Coefficient of Determination..... .7053
Corrected Coefficient of Determination.... .6924

ANALYSIS OF VARIANCE SUMMARY TABLE

Source of Variation	Sum of Squares	Deg. Freedom	Mean Square
Linear Regression	1.27944	7	.18278
Residuals from Regression	.53463	160	.00334
Corrected Total	1.81407	167	

F-Ratio = 54.70 with 7 and 160 Deg. Freedom
Significance Level of F-Ratio = .0000

Correction for Mean	6.74803	1	
Uncorrected Total	8.56210	168	

TABLE 6

BASIC REGRESSION STATISTICS
MODEL 1FC

Variables in the Equation

Variable	Type	Regression Coefficient	Std. Error of Regression Coefficient	Standardized Regression Coefficient	Partial Correlation Coefficient	T-Value with 163 Deg. Freedom	Partial F Value with 1 and 163 Deg. Freedom	Sig. Level
25 DIFF	dependent	----------	----------	----------	----------	----------	----------	-----
	constant	.039182	.012876		.232	3.04303	9.26002	.0027
19 DCM	independent	.047660	.007049	.3799	.468	6.76099	45.71096	.0000
4 TDS	independent	.010089	.001771	.2840	.407	5.69632	32.44009	.0000
16 OA	independent	.025302	.004335	.3425	.416	5.53724	34.07334	.0000
2 TDF	independent	.003817	.001913	.0963	.154	1.99570	3.98280	.0476

ANALYSIS OF VARIANCE SUMMARY TABLE

Source of Variation	Sum of Squares	Deg. Freedom	Mean Square
Linear Regression	1.19212	4	.29803
Residuals from Regression	.62195	163	.00382
Corrected Total	1.81407	167	
F-Ratio = 78.11 with 4 and 163 Deg. Freedom			
Significance Level of F-Ratio = .0000			
Correction for Mean	6.74803	1	
Uncorrected Total	8.56210	168	

Standard Error of Estimate.....	.0618
Multiple Correlation Coefficient.....	.8106
Coefficient of Determination.....	.6572
Corrected Coefficient of Determination....	.6487

TABLE 7

COMPARISON OF R^2 FOR MODELS 1, 1F, AND 1C

Full Model	Restricted Model	R^2 Diff.	Corr. R^2 Diff.
Model 1	Model 1F	.0710	.0634
Model 1	Model 1FC	.1191	.1071
Model 1F	Model 1FC	.0481	.0437

Model 2. The data for this model (using the four digit variables) are presented in Table 8. The model yielded an R^2 of .6879 and a corrected R^2 of .6802. The R^2 difference between Models 1 and 2 is presented in Table 9. A summary of the restricted models generated is presented in Table 62 in Appendix B.

Model 3. Cromer's process model (nine process variables) yielded an R^2 of .7454 and a corrected R^2 of .7309. A summary of the data for the model is presented in Table 10. The model thus accounted for less of the variance than did Model 1, but for more than Model 2. The factor analysis of these nine variables yielded five factors of which only four, accounting for 98.5 percent of the total factor variance, were considered. The percentage of the total factor variance and the percentage of the total variance accounted for are presented in Table 11. Table 12 presents the rotated factor matrix, which was used to see which variable correlated most highly with each factor. The variables DCM, OA, NDP, and SMD were then used to construct Model 3F. This factor model yielded an R^2 of .6628 and a corrected R^2 of .6545 and is presented in Table 13.

As with Model 1, the factoring procedure used by Cromer produced different factors from those in Model 3F. The factors he used were OM, OA, and NDP. These factors were used to produce Model 3FC, which is presented in Table 14. This model gave an R^2 of .6049 and a corrected R^2 of .5977.

In both cases, the factor models accounted for less of the variance than did the full model. The factors extracted in this study accounted for significantly more of the variance than did Cromer's factors. A summary of these comparisons is presented in Table 15. The restricted models generated from these three models are summarized in Tables 63, 64, and 65 in Appendix B.

Model 4. This complete flow chart model replaced the 2 Cromer variables OA and OM with the 10 new factors. In this model and in all the other complete models, TSM and TSA were not included, due to the linear dependence of the variables when the variables were included. Model 4 yielded an R^2 of .7855 and a corrected R^2 of .7564. These data for Model 4 are presented in Table 16. Model 4 accounted for somewhat more of the variance than did Model 1 for both the R^2 and corrected R^2 values.

The factor analysis of the variables in this model, omitting TSM and TSA, extracted 12 factors. Of these 12, 3 accounted for less than 1 percent of the total factor variance and were therefore not considered further. The percentage of total factor variance and the percentage of total variance for each of the remaining 9 factors are presented in Table 17. The rotated factor matrix for the 9 factors is presented in Table 18. The variables correlating most highly with each factor were chosen to represent that factor in the factor model. The variables that were used were NWA, YDM, YDA, LFS, UDS, LDF, SMD, NDP, and SDF. The model generated from these 9 variables, Model 4F, yielded an R^2 of .8521 and a corrected R^2 of .7105 (see Table 19). A summary of the comparison between Models 1, 1F, 4, and 4F is presented in Table 20. A summary of the restricted models for Model 4 is presented in Table 66 in Appendix B.

TABLE 8

BASIC REGRESSION STATISTICS
MODEL 2

Variables in the Equation

Variable	Type	Regression Coefficient	Std. Error of Regression Coefficient	Standardized Regression Coefficient	Partial Correlation Coefficient	T-Value with 163 Deg. Freedom	Partial F Value with 1 and 163 Deg. Freedom	Sig. Level
25 DIFF	dependent	----------	----------	----------	----------	----------	----------	-----
	constant	-.062142	.015824		-.294	-3.92698	15.42118	.0001
2 TDF	independent	.008252	.001749	.2082	.347	4.71828	22.26221	.0000
3 UDF	independent	.016824	.001553	.4749	.647	10.83299	117.35358	.0000
4 TDS	independent	.017945	.001565	.5051	.668	11.46772	131.50865	.0000
5 UDS	independent	.014583	.001633	.3913	.573	8.92913	79.72940	.0000

Standard Error of Estimate..... .0589
Multiple Correlation Coefficient..... .8294
Coefficient of Determination..... .6879
Corrected Coefficient of Determination.... .6802

ANALYSIS OF VARIANCE SUMMARY TABLE

Source of Variation	Sum of Squares	Deg. Freedom	Mean Square
Linear Regression	1.24791	4	.31198
Residuals from Regression	.56617	163	.00347
Corrected Total	1.81407	167	

F-Ratio = 89.82 with 4 and 163 Deg. Freedom
Significance Level of F-Ratio = .0000

Correction for Mean	6.74803	1	
Uncorrected Total	8.56210	168	

TABLE 9

COMPARISON OF R^2 FOR MODELS 1 AND 2

Full Model	Restricted Model	R^2 Diff.	Corr. R^2 Diff.
Model 1	Model 2	.0884	.0756

TABLE 10

BASIC REGRESSION STATISTICS
MODEL 3

Variables in the Equation

Variable		Type	Regression Coefficient	Std. Error of Regression Coefficient	Standardized Regression Coefficient	Partial Correlation Coefficient	T-Value with 158 Deg. Freedom	Partial F Value with 1 and 158 Deg. Freedom	Sig. Level
25	DIFF	dependent	----------	----------	----------	----------	----------	----------	-----
		constant	-.145857	.032013		-.341	-4.55619	20.75884	.0000
16	OA	independent	.030855	.007989	.4177	.294	3.86224	14.91687	.0002
17	OM	independent	-.020001	.007932	-.3986	-.197	-2.52155	6.35821	.0127
18	DCA	independent	-.024804	.012979	-.1732	-.150	-1.91105	3.65211	.0578
19	DCM	independent	.062731	.016006	.5001	.298	3.91930	15.36095	.0001
20	LDF	independent	.017825	.003229	.2520	.402	5.52011	30.47165	.0000
21	SDF	independent	.015983	.004741	.2517	.259	3.37141	11.36641	.0009
22	NDP	independent	.042715	.009755	.2669	.329	4.37896	19.17531	.0000
23	SMD	independent	-.043851	.011247	-.1637	-.296	-3.89908	15.20284	.0001
24	LFS	independent	.005263	.008992	.0249	.047	.58528	.34255	.5592

Standard Error of Estimate.....	.0541
Multiple Correlation Coefficient.....	.8634
Coefficient of Determination.....	.7454
Corrected Coefficient of Determination....	.7309

ANALYSIS OF VARIANCE SUMMARY TABLE

Source of Variation	Sum of Squares	Deg. Freedom	Mean Square
Linear Regression	1.35219	9	.15024
Residuals from Regression	.46188	158	.00292
Corrected Total	1.81407	167	
F-Ratio = 51.40 with 9 and 158 Deg. Freedom			
Significance Level of F-Ratio = .0000			
Correction for Mean	6.74803	1	
Uncorrected Total	8.56210	168	

TABLE 11

PROPORTION OF VARIANCE ACCOUNTED
FOR BY THE FACTORS
MODEL 3

Factor Number	Percentage of Total Factor Variance	Percentage of Total Variance
1	42.4	26.0
2	41.1	25.2
3	8.2	5.0
4	6.9	4.2

TABLE 12

ROTATED FACTOR MATRIX
MODEL 3

Var./Factor		1	2	3	4
1	OA	.370	.831	-.001	.277
2	OM	.864	.393	.229	.029
3	DCA	.240	.817	-.166	.297
4	DCM	.909	.243	.166	.030
5	LDF	.155	.462	.125	-.083
6	SDF	.664	.421	.217	.238
7	NDP	.309	.551	.386	-.097
8	SMD	.028	.043	.070	.365
9	LFS	.109	.006	.359	.093

TABLE 13

BASIC REGRESSION STATISTICS
MODEL 3F

Variables in the Equation

Variable	Type	Regression Coefficient	Std. Error of Regression Coefficient	Standardized Regression Coefficient	Partial Correlation Coefficient	T-Value with 163 Deg. Freedom	Partial F Value with 1 and 163 Deg. Freedom	Sig. Level
25 DIFF	dependent	----------	----------	----------	----------	----------	----------	-----
	constant	-.05026	.02867		-.136	-1.75310	3.07334	.0815
19 DCM	independent	.04437	.00692	.3537	.449	6.40853	41.06921	.0000
16 OA	independent	.02616	.00447	.3542	.417	5.85527	34.28424	.0000
22 NDP	independent	.04465	.00891	.2790	.365	5.01103	25.11041	.0000
23 SMD	independent	-.04313	.01238	-.1610	-.263	-3.48363	12.13569	.0006

ANALYSIS OF VARIANCE SUMMARY TABLE

Source of Variation	Sum of Squares	Deg. Freedom	Mean Square
Linear Regression	1.20231	4	.30058
Residuals from Regression	.61176	163	.00375
Corrected Total	1.81407	167	

F-Ratio = 80.09 with 4 and 163 Deg. Freedom
Significance Level of F-Ratio = .0000

Correction for Mean	6.74803	1	
Uncorrected Total	8.56210	168	

Standard Error of Estimate	.0613
Multiple Correlation Coefficient	.8141
Coefficient of Determination	.6628
Corrected Coefficient of Determination	.6545

TABLE 14

BASIC REGRESSION STATISTICS
MODEL 3FC

Variables in the Equation

Variable	Type	Regression Coefficient	Std. Error of Regression Coefficient	Standardized Regression Coefficient	Partial Correlation Coefficient	T-Value with 164 Deg. Freedom	Partial F Value with 1 and 164 Deg. Freedom	Sig. Level
25 DIFF	dependent	----------	----------	----------	----------	----------	----------	-----
	constant	-.04658	.03102		-.116	-1.50192	2.25576	.1350
17 CM	independent	.01699	.00357	.3386	.349	4.76605	22.71523	.0000
16 OA	independent	.02361	.00497	.3197	.348	4.75291	22.59016	.0000
22 NDP	independent	.03894	.01025	.2434	.284	3.79980	14.43849	.0002

Standard Error of Estimate..... .0661
Multiple Correlation Coefficient..... .7777
Coefficient of Determination..... .6049
Corrected Coefficient of Determination.... .5977

ANALYSIS OF VARIANCE SUMMARY TABLE

Source of Variation	Sum of Squares	Deg. Freedom	Mean Square
Linear Regression	1.09731	3	.36577
Residuals from Regression	.71676	164	.00437
Corrected Total	1.81407	167	

F-Ratio = 83.69 with 3 and 164 Deg. Freedom
Significance Level of F-Ratio = .0000

Correction for Mean	6.74803	1	
Uncorrected Total	8.56210	168	

TABLE 15

COMPARISON OF R^2 FOR MODELS 1, 3, 3F, AND 3FC

Full Model	Restricted Model	R^2 Diff.	Corr. R^2 Diff.
Model 1	Model 3	.0309	.0249
Model 3	Model 3F	.0826	.0764
Model 3	Model 3FC	.1449	.1332
Model 3F	Model 3FC	.0579	.0568

TABLE 16

BASIC REGRESSION STATISTICS
MODEL 4

Variables in the Equation

Variable		Type	Regression Coefficient	Std. Error of Regression Coefficient	Standardized Regression Coefficient	Partial Correlation Coefficient	T-Value with 147 Deg. Freedom	Partial F Value with 1 and 147 Deg. Freedom	Sig. Level
25	DIFF	dependent							
		constant	-.1800053	.0451931					
1	ORD	independent	.0001950	.0001702	.0455	-.312	-3.98302	15.86447	.0001
2	TDF	independent	.0068168	.0028727	.1720	.094	1.14557	1.31233	.2538
3	UDF	independent	.0118188	.0025346	.3336	.192	2.37297	5.63100	.0189
4	TDS	independent	.0098240	.0032082	.2765	.359	4.66299	21.74349	.0000
5	UDS	independent	.0100201	.0028751	.2689	.245	3.06218	9.37696	.0026
6	NDM	independent	.0115299	.0105030	.1522	.276	3.48510	12.14595	.0006
7	YDM	independent	.0247741	.0149570	.1712	.090	1.09777	1.20510	.2741
8	NOM	independent	-.0114823	.0092662	-.2837	.135	1.65636	2.74351	.0998
9	NWM	independent	.0441503	.0259303	.3707	-.102	-1.23916	1.53551	.2173
11	NDA	independent	-.0068228	.0157322	-.1103	.139	1.70265	2.89903	.0907
12	YDA	independent	.0088103	.0133731	.0737	-.036	-.43368	.18808	.6652
13	NOA	independent	-.0138578	.0167358	-.3060	.054	.65881	.43403	.5111
14	NWA	independent	.0198996	.0173346	.3165	-.068	-.82803	.68563	.4090
18	DCA	independent	.0271172	.0403950	.1894	.094	1.14797	1.31783	.2528
19	DCM	independent	.0056492	.0251660	.0450	.055	.67130	.45064	.5031
20	LDF	independent	.0060261	.0045815	.0852	.019	.22448	.05039	.8227
21	SDF	independent	.0073820	.0050743	.1162	.108	1.31532	1.73008	.1904
22	NDP	independent	-.0207586	.0207686	-.1297	.119	1.45478	2.11637	.1479
23	SMD	independent	-.0425639	.0122651	-.1589	-.082	-.99952	.99904	.3192
24	LPS	independent	-.0012848	.0151194	-.0061	-.275	-3.47032	12.04315	.0007
						-.007	-.08498	.00722	.9324

Standard Error of Estimate.....	.0514
Multiple Correlation Coefficient.....	.8863
Coefficient of Determination.....	.7855
Corrected Coefficient of Determination....	.7564

ANALYSIS OF VARIANCE SUMMARY TABLE

Source of Variation	Sum of Squares	Deg. Freedom	Mean Square
Linear Regression	1.42504	20	.07125
Residuals from Regression	.38903	147	.00265
Corrected Total	1.81407	167	
F-Ratio = 26.92 with 20 and 147 Deg. Freedom			
Significance Level of F-Ratio = .0000			
Correction for Mean	6.74803	1	
Uncorrected Total	8.56210	168	

TABLE 17

PROPORTION OF VARIANCE ACCOUNTED
FOR BY THE FACTORS
MODEL 4

Factor Number	Percentage of Total Factor Variance	Percentage of Total Variance
1	36.6	31.3
2	16.0	13.7
3	14.1	12.0
4	8.5	7.3
5	8.2	7.0
6	6.2	5.3
7	3.9	3.4
8	2.6	2.2
9	2.2	1.9

TABLE 18

ROTATED FACTOR MATRIX
MODEL 4

Var./Factor		1	2	3	4	5	6	7	8	9
1	TDF	.201	-.088	.068	-.753	-.098	.300	-.099	.106	.124
2	UDF	-.037	.772	.118	-.022	-.027	.240	-.108	-.185	.041
3	TDS	.685	.018	-.029	.308	-.241	.352	.138	.190	.241
4	UDS	.270	.003	.159	.055	.806	.100	.141	-.012	.004
5	NDM	.814	.076	.138	.050	.420	-.068	-.144	.120	.029
6	YDM	-.071	.886	-.009	.061	-.127	-.048	.026	.202	-.106
7	NOM	.656	.542	.123	.045	.361	.027	-.212	-.042	.189
8	NWM	.890	.102	.202	.107	.217	.067	-.212	.022	.063
9	NDA	.866	-.012	.330	.026	.143	.156	.103	-.202	-.125
10	YDA	.222	.049	.885	.045	.010	.074	.101	-.069	-.173
11	NOA	.649	.111	.637	-.097	.237	.150	.132	-.047	.158
12	NWA	.904	-.017	.268	.004	.054	.166	.114	-.130	-.047
13	DCA	.268	.145	.837	-.168	.211	.147	.130	.140	.251
14	DCM	.455	.801	.091	.048	.277	.037	.068	-.021	.111
15	LDF	.223	.153	.178	-.100	.108	.749	-.026	.009	.004
16	SDF	.607	.445	.171	-.074	.174	.091	.268	-.084	.282
17	NDP	.822	.061	.112	-.088	.018	.195	.013	.429	.011
18	SMD	-.018	-.017	.107	.034	.060	-.009	.548	.003	.007
19	LFS	.263	-.011	-.025	.798	-.015	.109	.142	.074	.090

TABLE 19

BASIC REGRESSION STATISTICS
MODEL 4F

Variables in the Equation

	Variable	Type	Regression Coefficient	Std. Error of Regression Coefficient	Standardized Regression Coefficient	Partial Correlation Coefficient	T-Value with 158 Deg. Freedom	Partial F Value with 1 and 158 Deg. Freedom	Sig. Level
25	DIFF	dependent	----------	----------	----------	----------	----------	----------	-----
		constant	-16.2541	3.3238		-.363	-4.89023	23.91435	.0000
14	NWA	independent	1.1477	.5437	.1823	.166	2.11091	4.45595	.0364
7	YDM	independent	2.7755	.7397	.1926	.286	3.75205	14.07785	.0002
12	YDA	independent	.7375	.5960	.0614	.098	1.23749	1.53138	.2177
24	LPS	independent	.6383	.9177	.0301	.055	.69554	.48377	.4877
5	UDS	independent	.3980	.1778	.1074	.175	2.23882	5.01231	.0266
20	LDF	independent	1.9599	.3293	.2771	.428	5.95112	35.41581	.0000
23	SMD	independent	-4.9882	1.1580	-.1862	-.324	-4.30776	18.55677	.0000
22	NDP	independent	2.3050	.9718	.1542	.185	2.37200	5.62637	.0189
21	SDF	independent	1.9972	.4171	.3145	.356	4.78806	22.92554	.0000

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Standard Error of Estimate..... 5.6079
Multiple Correlation Coefficient..... .8521
Coefficient of Determination..... .7261
Corrected Coefficient of Determination.... .7105

ANALYSIS OF VARIANCE SUMMARY TABLE

Source of Variation	Sum of Squares	Deg. Freedom	Mean Square
Linear Regression	13171.82620	9	1463.53624
Residuals from Regression	4968.88213	158	31.44862
Corrected Total	18140.70833	167	

F-Ratio = 46.54 with 9 and 158 Deg. Freedom
Significance Level of F-Ratio = .0000

Correction for Mean	67480.29167	1	
Uncorrected Total	85621.00000	168	

TABLE 20

COMPARISON OF R^2 FOR MODELS 1, 1F, 4, AND 4F

Full Model	Restricted Model	R^2 Diff.	Corr. R^2 Diff.
Model 1	Model 4	-.0116	.0001
Model 1	Model 4F	-.0758	.0453
Model 4	Model 4F	-.0666	.0006

Model 5. This model replaced the variables OA and OM in the set of Cromer process variables with the 10 new variables. Model 5 yielded an R^2 of .7405 and a corrected R^2 of .7149. The data for this model are presented in Table 21. This model accounted for less of the variance than did Model 4 and accounted for somewhat less than did Model 3.

The variables, omitting TSM and TSA, were then subjected to a factor analysis which yielded 10 factors. Of these factors, 2 were dropped from consideration since combined they accounted for .4 percent of the total factor variance. Table 22 presents the percentage of total factor variance and the percentage of total variance accounted for by the remaining 8 variables.

Table 23 presents the rotated factor matrix. This matrix was used to choose the variable that correlated most highly with each variable. These variables, NDM, YDA, YDM, LDF, SMD, LFS, NDA, and NDP, were then used to construct Model 5F. The data for the model are presented in Table 24. Model 5F yielded an R^2 of .6926 and a corrected R^2 of .6771, which accounted for less of the variation than did the full model, but which accounted for more than the Cromer process factor models (3F and 3FC). These comparisons are summarized in Table 25. A summary of the restricted models produced from these models is presented in Tables 67 and 68 in Appendix B.

Model 6. This model was produced using only the 10 new variables and is presented in Table 26. This model yielded an R^2 of .6400 and a corrected R^2 of .6219. Model 6 accounted for less of the variation than did Models 3 and 5.

The 8 variables, omitting TSM and TSA, were subjected to a factor analysis which yielded 4 factors. Table 27 gives the percentage of total factor variance and the percentage of total variance accounted for by each of these 4 factors.

Table 28 is the rotated factor matrix which was used to determine the variables that corresponded most highly with each factor. These variables, NDM, YDA, NWA, and YDM, were then used to construct the factor model. Model 6F yielded an R^2 of .5877 and a corrected R^2 of .5775. The data are presented in Table 29. Again, this factor model accounted for less of the variance than did the full model (Model 6) and also for less than the other process models (Models 3 and 5). Table 30 summarizes these comparisons. Tables 69 and 70 in Appendix B are a summary of the restricted models generated from these two models.

Model 7. This model was constructed using the 4 Cromer digit variables and the 10 new variables. Data for Model 7 are presented in Table 31. It yielded an R^2 of .7613 and a corrected R^2 of .7425. Compared with Models 1 and 4, this model accounted for less of the variance, but the difference was fairly small. The 12 variables in this model, omitting TSM and TSA, were subjected to a factor analysis which yielded 7 factors. Table 32 presents the percentage of total factor variance and the percentage of total variance accounted for by each factor. Using the rotated factor matrix found in Table 33, the variable correlating most highly with each factor was chosen to represent that factor in the factor model. The variables chosen to

TABLE 21

BASIC REGRESSION STATISTICS
MODEL 5

Variables in the Equation

Variable		Type	Regression Coefficient	Std. Error of Regression Coefficient	Standardized Regression Coefficient	Partial Correlation Coefficient	T-Value with 152 Deg. Freedom	Partial F Value with 1 and 152 Deg. Freedom	Sig. Level
25	DIFF	dependent	---	---	---	---	---	---	---
		constant	-.1862543	.0446404		-.321	-4.17232	17.40828	.0001
6	NDH	independent	.0148649	.0103697	.1962	.115	1.43349	2.05490	.1538
7	YDH	independent	.0326826	.0149858	.2259	.174	2.18091	4.75635	.0307
8	NOH	independent	-.0014088	.0096837	-.0348	-.012	-.14548	.02116	.8845
9	NWH	independent	.0120940	.0253626	.1016	.039	.47684	.22738	.6342
11	NDA	independent	-.0089055	.0164929	-.1439	-.044	-.53996	.29155	.5900
12	YDA	independent	-.0031587	.0140277	-.0264	-.018	-.22517	.05070	.8221
13	NOA	independent	.0020054	.0173437	.0443	.009	.11563	.01337	.9081
14	NWA	independent	.0194177	.0177619	.3088	.088	1.09322	1.19513	.2760
18	DCA	independent	.0129936	.0430065	.0907	.024	.30213	.09128	.7630
19	DCM	independent	.0001746	.0270303	.0014	.001	.00646	.00004	.9949
20	LDF	independent	.0223269	.0035578	.3157	.454	6.27549	39.38174	.0000
21	SDF	independent	.0153620	.0050308	.2419	.240	3.05359	9.32443	.0027
22	NDP	independent	-.0061990	.0202757	-.0387	-.025	-.30574	.09347	.7602
23	SMD	independent	-.0389648	.0129773	-.1455	-.237	-3.00254	9.01526	.0031
24	LPS	independent	.0044035	.0103562	.0208	.034	.42521	.18080	.6713

ANALYSIS OF VARIANCE SUMMARY TABLE

Source of Variation	Sum of Squares	Deg. Freedom	Mean Square
Linear Regression	1.34334	15	.08956
Residuals from Regression	.47073	152	.00310
Corrected Total	1.81407	167	

F-Ratio = 28.92 with 15 and 152 Deg. Freedom
Significance Level of F-Ratio = .0000

Correction for Mean	6.74803	1	
Uncorrected Total	8.56210	168	

Standard Error of Estimate..... .0556
Multiple Correlation Coefficient..... .8605
Coefficient of Determination..... .7405
Corrected Coefficient of Determination.... .7149

TABLE 22

PROPORTION OF VARIANCE ACCOUNTED
FOR BY THE FACTORS
MODEL 5

Factor Number	Percentage of Total Factor Variance	Percentage of Total Variance
1	43.5	35.2
2	18.5	15.0
3	15.8	12.8
4	7.2	5.8
5	4.7	3.8
6	4.1	3.3
7	2.9	2.4
8	2.9	2.3

TABLE 23

ROTATED FACTOR MATRIX
MODEL 5

Var./Factor		1	2	3	4	5	6	7	8
1	NDM	.910	.169	.087	-.038	-.104	.165	-.127	.037
2	YDM	-.102	.008	.905	-.003	-.018	.022	.012	.128
3	NOM	.740	.143	.518	.153	-.181	.123	-.127	-.232
4	NWM	.884	.221	.089	.160	-.179	.289	-.033	.015
5	NDA	.789	.342	-.058	.281	.111	.165	.340	-.063
6	YDA	.162	.896	.030	.090	.091	.096	.163	.024
7	NOA	.668	.625	.062	.305	.192	-.048	-.005	-.089
8	NWA	.802	.264	-.062	.329	.143	.145	.339	.019
9	DCA	.329	.814	.112	.277	.190	-.181	-.251	.001
10	DCM	.499	.107	.786	.189	.081	.087	-.037	-.213
11	LDF	.200	.213	.090	.492	-.033	.030	.017	.020
12	SDF	.621	.173	.397	.239	.298	.002	-.027	-.149
13	NDP	.743	.108	.091	.348	.018	.088	-.031	.445
14	SMD	-.040	.111	.004	-.016	.525	.090	.009	.003
15	LFS	.182	-.019	.046	.023	.105	.502	.014	.006

TABLE 24

BASIC REGRESSION STATISTICS
MODEL 5F

Variables in the Equation

Variable	Type	Regression Coefficient	Std. Error of Regression Coefficient	Standardized Regression Coefficient	Partial Correlation Coefficient	T-Value with 159 Deg. Freedom	Partial F Value with 1 and 159 Deg. Freedom	Sig. Level
25 DIFF	dependent	----------	----------	----------	----------	----------	----------	-----
	constant	-.268449	.037628		-.492	-7.13433	50.89865	.0000
6 NDM	independent	.020556	.005853	.2713	.268	3.51190	12.33346	.0006
12 YDA	independent	.002307	.006596	.0193	.028	.34979	.12235	.7270
7 YDM	independent	.042467	.006735	.2935	.447	6.30563	39.76093	.0000
20 LDF	independent	.024109	.003532	.3409	.476	6.82589	46.59274	.0000
23 SMD	independent	-.027921	.012169	-.1042	-.179	-2.29435	5.26402	.0231
24 LFS	independent	.001206	.009704	.0057	.010	.12428	.01544	.9013
11 NDA	independent	.018612	.005393	.3008	.264	3.45098	11.90929	.0007
22 NDP	independent	.010669	.011567	.0667	.073	.92238	.85079	.3577

Standard Error of Estimate..... .0592
Multiple Correlation Coefficient..... .8322
Coefficient of Determination..... .6926
Corrected Coefficient of Determination.... .6771

ANALYSIS OF VARIANCE SUMMARY TABLE

Source of Variation	Sum of Squares	Deg. Freedom	Mean Square
Linear Regression	1.25641	8	.15705
Residuals from Regression	.55766	159	.00351
Corrected Total	1.81407	167	

F-Ratio = 44.78 with 8 and 159 Deg. Freedom
Significance Level of F-Ratio = .0000

Correction for Mean	6.74803	1	
Uncorrected Total	8.56210	168	

TABLE 25

COMPARISON OF R^2 FOR MODELS 3, 3F, 3FC, 4, 5, AND 5F

Full Model	Restricted Model	R^2 Diff.	Corr. R^2 Diff.
Model 3	Model 5	.0049	.0160
Model 4	Model 5	.0450	.0415
Model 5	Model 5F	.0479	.0378
Model 3F	Model 5F	-.0300	-.0226
Model 3FC	Model 5F	-.0857	-.0949

TABLE 26

BASIC REGRESSION STATISTICS
MODEL 6

Variables in the Equation

	Variable	Type	Regression Coefficient	Std. Error of Regression Coefficient	Standardized Regression Coefficient	Partial Correlation Coefficient	T-Value with 159 Deg. Freedom	Partial F Value with 1 and 159 Deg. Freedom	Sig. Level
25	DIFF	dependent	----------	----------	----------	----------	----------	----------	------
		constant	-.028092	.037017		-.060	-.75891	.57595	.4490
6	MDM	independent	-.007109	.009797	-.0938	-.057	-.72560	.52650	.4692
7	YDM	independent	.033855	.009371	.2340	.275	3.61285	13.05267	.0004
8	NOM	independent	.008012	.004741	.1980	.133	1.68988	2.85571	.0930
9	NMM	independent	.029702	.020176	.2494	.116	1.47216	2.16724	.1430
11	MDA	independent	-.007123	.014551	-.1151	-.039	-.48954	.23965	.6251
12	YDA	independent	-.009197	.009488	-.0769	-.077	-.96927	.93948	.3339
13	NOA	independent	.016229	.005408	.3583	.232	3.00070	9.00421	.0031
14	NMA	independent	.017351	.013915	.2760	.098	1.24690	1.55477	.2143

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ANALYSIS OF VARIANCE SUMMARY TABLE

Source of Variation	Sum of Squares	Deg. Freedom	Mean Square
Linear Regression	1.16109	8	.14514
Residuals from Regression	.65298	159	.00411
Corrected Total	1.81407	167	

F-Ratio = 35.34 with 8 and 159 Deg. Freedom
Significance Level of F-Ratio = .0000

Correction for Mean	6.74803	1
Uncorrected Total	8.56210	168

Standard Error of Estimate.....	.0641
Multiple Correlation Coefficient.....	.8000
Coefficient of Determination.....	.6400
Corrected Coefficient of Determination....	.6219

TABLE 27

PROPORTION OF VARIANCE ACCOUNTED
FOR BY THE FACTORS
MODEL 6

Factor Number	Percentage of Total Factor Variance	Percentage of Total Variance
1	49.1	41.1
2	26.3	22.0
3	13.6	11.4
4	11.0	9.2

TABLE 28

ROTATED FACTOR MATRIX
MODEL 6

Var./Factor		1	2	3	4
1	NDM	.911	.202	.137	-.015
2	YDM	.028	-.007	-.064	.695
3	NOM	.786	.179	.191	.453
4	NWM	.896	.271	.263	.011
5	NDA	.612	.510	.557	-.157
6	YDA	.122	.798	.108	.030
7	NOA	.538	.722	.269	.006
8	NWA	.598	.442	.623	-.156

TABLE 29

BASIC REGRESSION STATISTICS
MODEL 6F

Variables in the Equation

Variable	Type	Regression Coefficient	Std. Error of Regression Coefficient	Standardized Regression Coefficient	Partial Correlation Coefficient	T-Value with 163 Deg. Freedom	Partial F Value with 1 and 163 Deg. Freedom	Sig. Level
25 DIFF	dependent	----------	----------	----------	----------	----------	----------	-----
	constant	-.098615	.027933		-.267	-3.53045	12.46410	.0005
6 NDM	independent	.020692	.005509	.2731	.282	3.75625	14.10939	.0002
12 YDA	independent	.005800	.006935	.0485	.065	.83636	.69949	.4042
14 NWA	independent	.029778	.005065	.4736	.418	5.87969	34.57070	.0000
7 YDM	independent	.049611	.007457	.3429	.462	6.65279	44.25958	.0000

ANALYSIS OF VARIANCE SUMMARY TABLE

Source of Variation	Sum of Squares	Deg. Freedom	Mean Square
Linear Regression	1.06605	4	.26651
Residuals from Regression	.74802	163	.00459
Corrected Total	1.81407	167	
F-Ratio = 58.08 with 4 and 163 Deg. Freedom			
Significance Level of F-Ratio = .0000			
Correction for Mean	6.74803	1	
Uncorrected Total	8.56210	168	

Standard Error of Estimate.....	.0677
Multiple Correlation Coefficient.....	.7666
Coefficient of Determination.....	.5877
Corrected Coefficient of Determination....	.5775

TABLE 30

COMPARISON OF R^2 FOR MODELS 3, 3F, 3FC, 5, 5F, 6, AND 6F

Full Model	Restricted Model	R^2 Diff.	Corr. R^2 Diff.
Model 3	Model 6	.1054	.1090
Model 5	Model 6	.1005	.0930
Model 6	Model 6F	.0523	.0444
Model 3F	Model 6F	.0749	.0770
Model 3FC	Model 6F	.0172	.0202
Model 5F	Model 6F	.0049	.0996

TABLE 31

BASIC REGRESSION STATISTICS
MODEL 7

Variables in the Equation

Variable	Type	Regression Coefficient	Std. Error of Regression Coefficient	Standardized Regression Coefficient	Partial Correlation Coefficient	T-Value with 155 Deg. Freedom	Partial F Value with 1 and 155 Deg. Freedom	Sig. Level
25 DIFF	dependent	----------	----------	----------	----------	----------	----------	-----
	constant	-.185236	.038536		-.360	-4.80680	23.10529	.0000
2 TDF	independent	.008324	.001845	.2100	.341	4.51149	20.35354	.0000
3 UDF	independent	.014833	.002147	.4187	.485	6.90902	47.73457	.0000
4 TDS	independent	.010406	.002178	.2929	.358	4.77783	22.82764	.0000
5 UDS	independent	.010903	.002373	.2926	.346	4.59549	21.11853	.0000
6 MDM	independent	.001191	.009280	.0157	.010	.12832	.01647	.8981
7 YDM	independent	.015354	.008864	.1061	.138	1.73219	3.00047	.0852
8 MOM	independent	-.004463	.004620	-.1103	-.077	-.96585	.93287	.3356
9 MWM	independent	.050688	.019941	.4256	.200	2.54188	6.46118	.0120
11 MDA	independent	-.006787	.013059	-.1097	-.042	-.51970	.27009	.6040
12 YDA	independent	.015048	.008532	.1258	.140	1.76375	3.11083	.0797
13 MOA	independent	-.004264	.005313	-.0941	-.064	-.80246	.64394	.4235
14 MWA	independent	.008125	.012851	.1292	.051	.63228	.39978	.5281

Standard Error of Estimate..... .0529
Multiple Correlation Coefficient..... .8725
Coefficient of Determination..... .7613
Corrected Coefficient of Determination.... .7428

ANALYSIS OF VARIANCE SUMMARY TABLE

Source of Variation	Sum of Squares	Deg. Freedom	Mean Square
Linear Regression	1.38104	12	.11509
Residuals from Regression	.43303	155	.00279
Corrected Total	1.81407	167	

F-Ratio = 41.19 with 12 and 155 Deg. Freedom
Significance Level of F-Ratio = .0000

Correction for Mean	6.74303	1	
Uncorrected Total	8.56210	168	

TABLE 32

PROPORTION OF VARIANCE ACCOUNTED
FOR BY THE FACTORS
MODEL 7

Factor Number	Percentage of Total Factor Variance	Percentage of Total Variance
1	37.6	29.0
2	20.0	15.5
3	17.1	13.2
4	16.1	12.4
5	5.4	4.2
6	2.0	1.5
7	1.8	1.4

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TABLE 33

ROTATED FACTOR MATRIX
MODEL 7

Var./Factor		1	2	3	4	5	6	7
1	TDF	.095	-.020	.066	-.070	.540	.002	.007
2	UDF	.009	.022	.109	.776	-.003	-.050	.083
3	TDS	.767	-.050	.028	.020	.093	-.062	-.081
4	UDS	.111	.768	.176	-.077	-.049	-.049	.046
5	NDM	.663	.621	.134	.008	.033	.264	-.067
6	YDM	-.006	-.065	-.032	.778	-.116	.051	-.094
7	NOM	.564	.560	.081	.499	.063	.168	-.022
8	NWM	.816	.433	.213	.068	.052	.251	-.038
9	NDA	.736	.336	.473	-.052	.136	-.036	.275
10	YDA	.146	.114	.825	.071	.046	.028	.007
11	NOA	.495	.425	.634	.103	.332	-.044	-.011
12	NWA	.803	.258	.394	-.048	.211	-.097	.237

represent the factors were NWM, UDS, YDA, YDM, TDF, NDM, and NDA. The data for Model 7F are presented in Table 34. Model 7F yielded an R^2 of .6495 and a corrected R^2 of .6342. Model 7F accounted for less of the variance than did Model 7. The comparisons between the R^2 for this model and the other models are summarized in Table 35. A summary of the restricted models generated from these models is found in Tables 71 and 72 in Appendix B.

Model 8. This model used the 10 new variables plus the Cromer process variables LDF, SDF, NDP, SMD, and LFS. Data for Model 8 are presented in Table 36. Model 8 had an R^2 value of .7404 and a corrected R^2 of .7184. When compared on the basis of R^2 to the other process models (Models 3, 5, and 6), Model 8 came out very favorably. The 13 linearly independent variables for Model 8 were subjected to a factor analysis which extracted 8 factors. Table 37 reports the percentage of total variance and the percentage of total variance accounted for by each variable.

Table 38, the rotated factor matrix, was used to determine which of the variables correlated most highly with each of the factors. These variables, NDM, YDA, YDM, LDF, SMD, LFS, NWA, and NDP, were then used to construct Model 8F. Data for Model 8F are found in Table 39. This model had an R^2 of .7016 and a corrected R^2 of .6866. Model 8F accounted for more of the variance than did the factor model of the 10 new variables (Model 6F) and the Cromer process factor model (Model 3F) and for about the same amount as Model 5F. A summary of the differences between this model and the other models is presented in Table 40. The restricted models are summarized in Tables 73 and 74 in Appendix B.

Model 9. This model contains the same 15 variables as the previous model, but has, in addition, the 4 Cromer digit variables. The data are found in Table 41 and had an R^2 of .7831 and a corrected R^2 of .7585. Model 9 was about the same or somewhat better than the process and digit models (1 and 7) when comparing R^2 values and was also better than Model 4 when comparing corrected R^2 values. These 17 variables, omitting TSM and TSA, were then subjected to a factor analysis which identified 10 factors, of which 1 factor was eliminated from consideration, since it accounted for .1 percent of the total factor variance. Table 42 lists the percentage of the total factor variance and the percentage of the total variance accounted for by each variable. Using the rotated factor matrix, found in Table 43, the variable corresponding most highly with each factor was then determined. These variables, NWM, YDM, LFS, YDA, UDS, LDF, SMD, NDA, and SDF, were then used to construct Model 9F. Data for Model 9F are given in Table 44. This model had an R^2 of .7339 and a corrected R^2 of .7187. The comparisons of the R^2 for Models 9 and 9F to the other factor models for the digit and process models are summarized in Table 45. The summary of the restricted models for both Models 9 and 9F is given in Tables 75 and 76 in Appendix B.

Model 10. This model was constructed using the 10 new variables and the Cromer process variables LDF, SDF, NDP, and LFS. Data for Model 10 are presented in Table 46. This model had an R^2 of .7245 and a corrected R^2 of .7032. Model 10 accounted for less of the

TABLE 34

BASIC REGRESSION STATISTICS
MODEL 7F

Variables in the Equation

Variable		Type	Regression Coefficient	Std. Error of Regression Coefficient	Standardized Regression Coefficient	Partial Correlation Coefficient	T-Value with 160 Deg. Freedom	Partial F Value with 1 and 160 Deg. Freedom	Sig. Level
25	DIFF	dependent							
		constant	-.134973	.028757		-.348	-4.69356	22.02948	.0000
9	NWM	independent	.079229	.018909	.6653	.314	4.18995	17.55565	.0000
5	UDS	independent	.008322	.002304	.2233	.275	3.61177	13.04490	.0004
12	YDA	independent	.003262	.006936	.0273	.037	.47033	.22121	.6388
7	YDM	independent	.050079	.007168	.3461	.483	6.98614	48.80609	.0000
2	TDF	independent	.007743	.001918	.1954	.304	4.03635	16.29209	.0001
6	NDM	independent	-.021024	.010601	-.2774	-.155	-1.98317	3.93295	.0491
11	NDA	independent	.011855	.006408	.1916	.145	1.85020	3.42323	.0661

Standard Error of Estimate.....	.0630
Multiple Correlation Coefficient.....	.8059
Coefficient of Determination.....	.6495
Corrected Coefficient of Determination....	.6342

ANALYSIS OF VARIANCE SUMMARY TABLE

Source of Variation	Sum of Squares	Deg. Freedom	Mean Square
Linear Regression	1.17825	7	.16832
Residuals from Regression	.63582	160	.00397
Corrected Total	1.81407	167	
F-Ratio = 42.36 with 7 and 160 Deg. Freedom			
Significance Level of F-Ratio = .0000			
Correction for Mean	6.74803	1	
Uncorrected Total	8.56210	168	

TABLE 35

COMPARISON OF R^2 FOR MODELS 1, 1F, 1FC, 4, 6, 7, AND 7F

Full Model	Restricted Model	R^2 Diff.	Corr. R^2 Diff.
Model 7	Model 6	-.1213	-.1209
Model 1	Model 7	.0150	.0130
Model 4	Model 7	.0242	.0136
Model 7	Model 7F	.1118	.1086
Model 1F	Model 7F	.0558	.0582
Model 1FC	Model 7F	.0077	.0145

TABLE 36

BASIC REGRESSION STATISTICS
MODEL 8

Variables in the Equation

Variable		Type	Regression Coefficient	Std. Error of Regression Coefficient	Standardized Regression Coefficient	Partial Correlation Coefficient	T-Value with 154 Deg. Freedom	Partial F Value with 1 and 154 Deg. Freedom	Sig. Level
25	DIFF	dependent							
		constant	-.19044239	.04208805		-.343	-4.52486	20.47433	.0000
6	NDM	independent	.01396275	.00983890	.1843	.114	1.41914	2.01395	.1579
7	YDM	independent	.03125998	.00935971	.2160	.260	3.33985	11.15457	.0011
8	NOM	independent	-.00084095	.00505017	-.0208	-.013	-.16652	.02773	.8680
9	NWM	independent	.01091722	.01973900	.0917	.045	.55308	.30590	.5810
11	NDA	independent	-.01073812	.01479015	-.1735	-.058	-.72603	.52712	.4689
12	YDA	independent	.00001426	.00862094	.0001	.000	.00165	.00000	.9987
13	NOA	independent	.00699177	.00534697	.1544	.105	1.30761	1.70986	.1930
14	NWA	independent	.01666415	.01512837	.2650	.088	1.10152	1.21334	.2724
20	LDF	independent	.02240831	.00352428	.3168	.456	6.35827	40.42761	.0000
21	SDF	independent	.01553211	.00491732	.2446	.247	3.15865	9.97709	.0019
22	NDP	independent	-.00223965	.01537274	-.0140	-.012	-.14569	.02123	.8844
23	SMD	independent	-.03859627	.01258970	-.1441	-.240	-3.06570	9.39853	.0026
24	LFS	independent	.00411366	.00975523	.0194	.034	.42169	.17782	.6738

ANALYSIS OF VARIANCE SUMMARY TABLE

Source of Variation	Sum of Squares	Deg. Freedom	Mean Square
Linear Regression	1.34306	13	.10331
Residuals from Regression	.47101	154	.00306
Corrected Total	1.81407	167	

F-Ratio = 33.78 with 13 and 154 Deg. Freedom
Significance Level of F-Ratio = .0000

Correction for Mean	6.74803	1	
Uncorrected Total	8.56210	168	

Standard Error of Estimate..... .0553
Multiple Correlation Coefficient..... .8604
Coefficient of Determination..... .7404
Corrected Coefficient of Determination.... .7184

TABLE 37

PROPORTION OF VARIANCE ACCOUNTED
FOR BY THE FACTORS
MODEL 8

Factor Number	Percentage of Total Factor Variance	Percentage of Total Variance
1	49.8	36.3
2	14.3	10.5
3	10.1	7.4
4	9.9	7.2
5	5.5	4.0
6	5.1	3.7
7	2.7	2.0
8	2.6	1.9

TABLE 38

ROTATED FACTOR MATRIX
MODEL 8

Var./Factor		1	2	3	4	5	6	7	8
1	NDM	.911	.155	-.031	.013	-.107	.209	-.068	.107
2	YDM	.023	-.014	.782	.035	.007	.018	-.021	.008
3	NOM	.805	.118	.412	.174	-.155	.146	.011	-.170
4	NWM	.862	.217	-.018	.212	-.169	.328	.021	.055
5	NDA	.709	.410	-.194	.317	.104	.218	.327	.012
6	YDA	.189	.780	.013	.177	.152	.034	.026	.016
7	NOA	.665	.581	-.026	.342	.198	-.023	.028	-.022
8	NWA	.718	.306	-.194	.369	.138	.199	.361	.093
9	LDF	.193	.189	.062	.505	-.025	.025	.022	.020
10	SDF	.676	.122	.307	.265	.308	.026	.099	-.132
11	NDP	.690	.076	.028	.387	.012	.151	.048	.419
12	SMD	-.042	.099	-.002	-.012	.506	.084	.010	.003
13	LFS	.166	.013	.022	.022	.095	.441	.015	.012

TABLE 39

BASIC REGRESSION STATISTICS
MODEL 8F

Variables in the Equation

Variable		Type	Regression Coefficient	Std. Error of Regression Coefficient	Standardized Regression Coefficient	Partial Correlation Coefficient	T-Value with 159 Deg. Freedom	Partial F Value with 1 and 159 Deg. Freedom	Sig. Level
25	DIFF	dependent	----------	----------	----------	----------	----------	----------	-----
		constant	-.25008418	.03788006		-.464	-6.60200	43.58642	.0000
6	NDM	independent	.02309881	.00533357	.3048	.325	4.33084	18.75613	.0000
12	YDA	independent	.00321598	.00617629	.0269	.041	.52070	.27113	.6033
7	YDM	independent	.04439289	.00668410	.3068	.466	6.64157	44.11039	.0000
20	LDF	independent	.02447479	.00344288	.3461	.491	7.10882	50.53530	.0000
23	SMD	independent	-.02826840	.01197757	-.1055	-.184	-2.36011	5.57013	.0195
24	LFS	independent	-.00008086	.00957811	-.0004	-.001	-.00844	.00007	.9933
14	NWA	independent	.02192096	.00530165	.3406	.312	4.13475	17.09613	.0001
22	NDP	independent	-.00273262	.01247945	-.0171	-.017	-.21897	.04795	.8270

ANALYSIS OF VARIANCE SUMMARY TABLE

Source of Variation	Sum of Squares	Deg. Freedom	Mean Square
Linear Regression	1.27284	8	.15910
Residuals from Regression	.54123	159	.00340
Corrected Total	1.81407	167	
F-Ratio = 46.74 with 8 and 159 Deg. Freedom			
Significance Level of F-Ratio = .0000			
Correction for Mean	6.74803	1	
Uncorrected Total	8.56210	168	

Standard Error of Estimate.....	.0583
Multiple Correlation Coefficient.....	.8376
Coefficient of Determination.....	.7016
Corrected Coefficient of Determination....	.6866

TABLE 40

COMPARISON OF R^2 FOR MODELS
3, 3F, 3FC, 5, 5F, 6, 6F, 8, AND 8F

Full Model	Restricted Model	R^2 Diff.	Corr. R^2 Diff.
Model 3	Model 8	.0050	.0125
Model 5	Model 8	.0001	-.0035
Model 6	Model 8	-.1004	-.0865
Model 8	Model 8F	.0523	.0444
Model 3F	Model 8F	-.0390	-.0321
Model 3FC	Model 8F	-.0967	-.0889
Model 5F	Model 8F	-.0090	-.0095
Model 6F	Model 8F	-.1139	-.1091

TABLE 41

BASIC REGRESSION STATISTICS
MODEL 9

Variables in the Equation

Variable		Type	Regression Coefficient	Std. Error of Regression Coefficient	Standardized Regression Coefficient	Partial Correlation Coefficient	T-Value with 150 Deg. Freedom	Partial F Value with 1 and 150 Deg. Freedom	Sig. Level
25	DIFF	dependent	----------	----------	----------	----------	----------	----------	-----
		constant	-.183932	.043250		-.328	-4.25273	18.08568	.0000
2	TDF	independent	.006542	.002819	.1651	.186	2.32035	5.38402	.0217
3	UDF	independent	.011930	.002517	.3368	.361	4.74054	22.47274	.0000
4	TDS	independent	.009967	.003187	.2806	.247	3.12692	9.77762	.0021
5	UDS	independent	.010170	.002840	.2729	.281	3.58148	12.82697	.0005
6	NDM	independent	.010187	.010138	.1344	.082	1.00485	1.00972	.3166
7	YDM	independent	.023434	.010067	.1620	.187	2.32794	5.41931	.0213
8	NOM	independent	-.008433	.005147	-.2084	-.133	-1.63855	2.68486	.1034
9	NWM	independent	.038272	.021278	.3214	.145	1.79863	3.23508	.0741
11	NDA	independent	-.011905	.014230	-.1924	-.068	-.83664	.69997	.4041
12	YDA	independent	.014736	.008730	.1232	.137	1.68798	2.84926	.0935
13	NOA	independent	-.002869	.005493	-.0633	-.043	-.52225	.27274	.6023
14	NWA	independent	.015542	.014694	.2472	.086	1.05770	1.11873	.2919
20	LDF	independent	.006621	.004516	.0936	.119	1.46611	2.14947	.1447
21	SDF	independent	.007167	.004903	.1129	.119	1.46187	2.13705	.1459
22	NDP	independent	-.012223	.016157	-.0764	-.062	-.75651	.57230	.4505
23	SMD	independent	-.040167	.011356	-.1499	-.267	-3.38794	11.47813	.0009
24	LFS	independent	-.002479	.014655	-.0117	-.014	-.16914	.02861	.8659

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Standard Error of Estimate..... .0512
Multiple Correlation Coefficient..... .8849
Coefficient of Determination..... .7831
Corrected Coefficient of Determination.... .7585

ANALYSIS OF VARIANCE SUMMARY TABLE

Source of Variation	Sum of Squares	Deg. Freedom	Mean Square
Linear Regression	1.42056	17	.08356
Residuals from Regression	.39351	150	.00262
Corrected Total	1.81402	167	

F-Ratio = 31.85 with 17 and 150 Deg. Freedom
Significance Level of F-Ratio = .0000

Correction for Mean	6.74803	1	
Uncorrected Total	8.56210	168	

TABLE 42

PROPORTION OF VARIANCE ACCOUNTED
FOR BY THE FACTORS
MODEL 9

Factor Number	Percentage of Total Factor Variance	Percentage of Total Variance
1	42.9	34.8
2	12.7	10.3
3	9.9	8.0
4	9.8	7.9
5	8.7	7.0
6	7.6	6.2
7	4.5	3.7
8	2.3	1.8
9	1.6	1.3

TABLE 43

ROTATED FACTOR MATRIX
MODEL 9

Var./Factor		1	2	3	4	5	6	7	8	9
1	TDF	.221	-.106	-.749	-.005	-.116	.321	.109	-.108	.040
2	UDF	.002	.805	-.026	.107	.023	.214	-.088	.160	.122
3	TDS	.705	-.029	.320	-.088	-.278	.379	.160	-.117	.062
4	UDS	.294	-.059	.053	.109	.801	.107	.151	.023	.013
5	NDM	.852	-.004	.054	.104	.398	-.054	-.136	-.108	-.032
6	YDM	.015	.824	.061	-.036	-.086	-.050	.029	-.141	-.108
7	NOM	.727	.461	.049	.063	.352	.036	-.167	-.059	.175
8	NWM	.909	.029	.112	.188	.202	.083	-.206	-.043	.065
9	NDA	.815	-.082	.031	.388	.139	.163	.090	.315	.036
10	YDA	.234	.061	.004	.812	.064	.092	.134	.013	-.018
11	NOA	.672	.065	-.112	.567	.238	.189	.180	.011	.145
12	NWA	.860	-.086	.010	.303	.041	.182	.113	.307	.031
13	LDF	.227	.153	-.100	.152	.118	.748	-.020	.027	.002
14	SDF	.659	.386	-.072	.088	.177	.102	.302	.029	.263
15	NDP	.858	.008	-.080	.046	-.020	.225	.048	-.153	-.236
16	SMD	-.021	-.029	.032	.094	.059	-.004	.527	.003	.001
17	LFS	.263	-.040	.797	-.018	-.031	.115	.144	-.082	.028

TABLE 44

BASIC REGRESSION STATISTICS
MODEL 9F

Variables in the Equation

	Variable	Type	Regression Coefficient	Std. Error of Regression Coefficient	Standardized Regression Coefficient	Partial Correlation Coefficient	T-Value with 158 Deg. Freedom	Partial F Value with 1 and 158 Deg. Freedom	Sig. Level
25	DIFF	dependent	----------	----------	----------	----------	----------	----------	-----
		constant	-.1784991	.0322411		-.403	-5.53639	30.65157	.0000
9	NWM	independent	.0330763	.0103117	.2777	.247	3.20764	10.28893	.0016
7	YDM	independent	.0286724	.0071147	.1982	.305	4.03001	16.24095	.0001
24	LFS	independent	-.0005341	.0093040	-.0025	-.005	-.05741	.00330	.9543
12	YDA	independent	.0047761	.0061327	.0399	.062	.77879	.60651	.4373
5	UDS	independent	.0025477	.0018000	.0684	.112	1.41537	2.00328	.1589
20	LDF	independent	.0213456	.0032116	.3018	.467	6.64649	44.17578	.0000
23	SMD	independent	-.0363790	.0123142	-.1358	-.229	-2.95423	8.72749	.0036
11	NDA	independent	.0062222	.0059994	.1006	.082	1.03714	1.07566	.3013
21	SDF	independent	.0184435	.0040114	.2904	.344	4.59781	21.13984	.0000

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ANALYSIS OF VARIANCE SUMMARY TABLE

Source of Variation	Sum of Squares	Deg. Freedom	Mean Square
Linear Regression	1.33129	9	.14792
Residuals from Regression	.48278	158	.00306
Corrected Total	1.81407	167	
F-Ratio = 48.41 with 9 and 158 Deg. Freedom			
Significance Level of F-Ratio = .0000			
Correction for Mean	6.74803	1	
Uncorrected Total	8.56210	168	

Standard Error of Estimate.....	.0553
Multiple Correlation Coefficient.....	.8567
Coefficient of Determination.....	.7339
Corrected Coefficient of Determination....	.7187

TABLE 45

COMPARISON OF R^2 FOR MODELS
1, 1F, 1FC, 4, 4F, 7, 7F, 8, 9, AND 9F

Full Model	Restricted Model	R^2 Diff.	Corr. R^2 Diff.
Model 9	Model 8	.0427	.0401
Model 1	Model 9	-.0068	-.0027
Model 4	Model 9	.0024	-.0021
Model 7	Model 9	-.0218	-.0157
Model 9	Model 9F	.0492	.0398
Model 1F	Model 9F	-.0286	-.0243
Model 1FC	Model 9F	-.0767	-.0700
Model 4F	Model 9F	.0516	.0377
Model 7F	Model 9F	.0844	.0845

TABLE 46

BASIC REGRESSION STATISTICS
MODEL 10

Variables in the Equation

	Variable	Type	Regression Coefficient	Std. Error of Regression Coefficient	Standardized Regression Coefficient	Partial Correlation Coefficient	T-Value with 155 Deg. Freedom	Partial F Value with 1 and 155 Deg. Freedom	Sig. Level
25	DIFF	dependent	----------	----------	----------	----------	----------	----------	-----
		constant	-.2071055	.0428514		-.362	-4.83311	23.35895	.0000
6	NDM	independent	.0093052	.0099808	.1228	.075	.93231	.86921	.3526
7	YDM	independent	.0291295	.0095834	.2013	.237	3.03957	9.23901	.0028
8	NOM	independent	.0016654	.0051168	.0411	.026	.32547	.10593	.7453
9	NWM	independent	.0244416	.0197541	.2052	.099	1.23729	1.53089	.2178
11	NDA	independent	-.0130087	.0151665	-.2102	-.069	-.85773	.73569	.3924
12	YDA	independent	.0002124	.0088512	.0018	.002	.02400	.00058	.9809
13	NOA	independent	.0052023	.0054571	.1149	.076	.95331	.90879	.3419
14	NWA	independent	.0169178	.0155326	.2691	.087	1.08918	1.18632	.2778
20	LDF	independent	.0227405	.0036168	.3215	.451	6.28750	39.53267	.0000
21	SDF	independent	.0123527	.0049352	.1945	.197	2.50297	6.26487	.0134
22	NDP	independent	-.0021400	.0157837	-.0134	-.011	-.13558	.01838	.8923
24	LFS	independent	-.0019416	.0098086	-.0092	-.016	-.19795	.03918	.8433

Standard Error of Estimate..... .0568
Multiple Correlation Coefficient..... .8512
Coefficient of Determination..... .7245
Corrected Coefficient of Determination.... .7032

ANALYSIS OF VARIANCE SUMMARY TABLE

Source of Variation	Sum of Squares	Deg. Freedom	Mean Square
Linear Regression	1.31431	12	.10953
Residuals from Regression	.49976	155	.00322
Corrected Total	1.81407	167	

F-Ratio = 33.97 with 12 and 155 Deg. Freedom
Significance Level of F-Ratio = .0000

Correction for Mean	6.74803	1	
Uncorrected Total	8.56210	168	

variance than did the other process models (3, 5, and 8). It accounted for somewhat more of the variance than did Model 6, which consisted of only the 10 new variables.

A factor analysis was then run on these 12 variables, omitting TSM and TSA, to find a smaller set of factors that would account for approximately the same amount of the variance. Eight factors were extracted, of which 1 was eliminated from further consideration, since it accounted for only .7 percent of the total factor variance. Table 47 gives the percentage of the total factor variance and the percentage of total variance accounted for by each factor. Using the rotated factor matrix found in Table 48, the variable correlating most highly with each factor was identified, and these variables, NDM, YDA, YDM, LDF, SDF, LFS, and NDP, were used to construct Model 10F. Model 10F, the data for which appear in Table 49, had an R^2 value of .7101 and a corrected R^2 value of .6974. This model has the highest value of R^2 and corrected R^2 for all the process models considered so far. The comparisons are summarized in Table 50. A summary of the restricted models is given in Tables 77 and 78 in Appendix B.

Model 11. This model contains the same variables as Model 10 but has, in addition, the 4 Cromer digit variables. The data for Model 11 are presented in Table 51. It yielded an R^2 value of .7665 and a corrected R^2 of .7417. These R^2 values are lower than those for the process and digit models 1, 4, and 9. The corrected R^2 value is also lower than the corrected R^2 of Model 7.

The 16 variables, omitting TSM and TSA, were subjected to a factor analysis which yielded 10 factors, of which one factor was dropped from consideration since, when it was combined the other factors accounted for only .0 percent of the total factor variance. Table 52 gives the percentage of factor variance and the percentage of total variance accounted for by each factor. The rotated factor matrix, given in Table 53, was then used to determine which variable correlated most highly with each factor. The variables identified were NWM, YDM, YDA, TDF, UDS, TDS, LDF, NWA, and NDP. These variables were then used to construct Model 11F, data for which are given in Table 54. This model had an R^2 value of .7143 and a corrected R^2 of .6980. These values are above the values of some of the models (Models 1F, 1FC, and 7F) and below Model 9F. These comparisons are summarized in Table 55. A summary of the restricted models for these two models is presented in Tables 79 and 80 in Appendix B.

The 24 One-Variable Models. Each of the 24 variables was used to construct a model to test the amount of the variance accounted for by that variable. The R^2 values ranged from .0060 for ORD to .5254 for TSM. The findings for these 24 models are summarized in Table 56. All of the factors except ORD, SMD, and LFS accounted for a significant proportion of the variance at the .01 level.

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TABLE 47

PROPORTION OF VARIANCE ACCOUNTED
FOR BY THE FACTORS
MODEL 10

Factor Number	Percentage of Total Factor Variance	Percentage of Total Variance
1	38.8	29.4
2	18.7	14.2
3	10.5	7.9
4	10.3	7.8
5	9.9	7.5
6	7.0	5.3
7	4.1	3.1

TABLE 48

ROTATED FACTOR MATRIX
MODEL 10

Var./Factor		1	2	3	4	5	6	7
1	NDM	.894	.189	-.037	.069	.113	.227	.144
2	YDM	.028	-.019	.781	.035	.009	.017	.002
3	NOM	.771	.137	.399	.212	.242	.188	-.104
4	NWM	.817	.241	-.026	.250	.148	.379	.105
5	NDA	.503	.479	-.201	.311	.418	.313	.138
6	YDA	.110	.809	.020	.163	.053	.063	.023
7	NOA	.522	.663	-.022	.330	.323	.030	.079
8	NWA	.508	.392	-.201	.341	.481	.318	.252
9	LDF	.138	.205	.061	.506	.088	.043	.048
10	SDF	.499	.233	.307	.236	.511	.087	.034
11	NDP	.594	.138	.028	.399	.150	.197	.491
12	LFS	.145	.030	.025	.028	.034	.397	.023

TABLE 49

BASIC REGRESSION STATISTICS
MODEL 10F

Variables in the Equation

Variable		Type	Regression Coefficient	Std. Error of Regression Coefficient	Standardized Regression Coefficient	Partial Correlation Coefficient	T-Value with 160 Deg. Freedom	Partial F Value with 1 and 160 Deg. Freedom	Sig. Level
25	DIFF	dependent							
		constant	-.254490	.035496		-.493	-7.16954	51.40226	.0000
6	NDM	independent	.022427	.005224	.2960	.321	4.29283	18.42843	.0000
12	YDA	independent	.007947	.005504	.0665	.113	1.44383	2.08464	.1507
7	YDM	independent	.024554	.006565	.1697	.284	3.74010	13.98831	.0003
20	LDF	independent	.024655	.003370	.3486	.501	7.31635	53.52894	.0000
21	SDF	independent	.018769	.003656	.2956	.376	5.13315	26.34922	.0000
24	LFS	independent	.001749	.009278	.0083	.015	.18851	.03554	.8507
22	NDP	independent	.014354	.010761	.0897	.105	1.33390	1.77930	.1841

Standard Error of Estimate..... .0573
Multiple Correlation Coefficient..... .8426
Coefficient of Determination..... .7101
Corrected Coefficient of Determination.... .6974

ANALYSIS OF VARIANCE SUMMARY TABLE

Source of Variation	Sum of Squares	Deg. Freedom	Mean Square
Linear Regression	1.28809	7	.18401
Residuals from Regression	.52598	160	.00329
Corrected Total	1.81407	167	

F-Ratio = 55.98 with 7 and 160 Deg. Freedom
Significance Level of F-Ratio = .0000

Correction for Mean	6.74803	1	
Uncorrected Total	8.56210	168	

TABLE 50

COMPARISON OF R^2 FOR MODELS
3, 3F, 3FC, 5, 5F, 6, 6F, 8, 8F, 10, AND 10F

Full Model	Restricted Model	R^2 Diff.	Corr. R^2 Diff.
Model 3	Model 10	.0209	.0277
Model 5	Model 10	.0160	.0117
Model 6	Model 10	-.0845	-.0813
Model 8	Model 10	.0159	.0152
Model 10	Model 10F	.0144	.0058
Model 3F	Model 10F	-.0475	-.0439
Model 3FC	Model 10F	-.1052	-.0997
Model 5F	Model 10F	-.0175	-.0197
Model 6F	Model 10F	-.1224	-.1199
Model 8F	Model 10F	-.0085	-.0108

TABLE 51

BASIC REGRESSION STATISTICS
MODEL 11

Variables in the Equation

Variable	Type	Regression Coefficient	Std. Error of Regression Coefficient	Standardized Regression Coefficient	Partial Correlation Coefficient	T-Value with 151 Deg. Freedom	Partial F Value with 1 and 151 Deg. Freedom	Sig. Level
25 DIFF	dependent	---	---	---	---	---	---	---
	constant	-.202444	.044367		-.348	-4.56290	20.82009	.0000
2 TDF	independent	.005648	.002903	.1425	.156	1.94570	3.78574	.0535
3 UDF	independent	.012221	.002601	.3450	.357	4.69871	22.07787	.0000
4 TDS	independent	.009641	.003295	.2714	.232	2.92623	8.56283	.0040
5 UDS	independent	.008830	.002908	.2369	.240	3.03637	9.21957	.0028
6 NDM	independent	.007492	.010452	.0989	.058	.71686	.51389	.4746
7 YDM	independent	.018453	.010298	.1275	.144	1.79184	3.21070	.0752
8 NOM	independent	-.005368	.005240	-.1326	-.083	-1.02450	1.04960	.3072
9 NWM	independent	.047127	.021837	.3957	.173	2.15808	4.65730	.0325
11 NDA	independent	-.012338	.014715	-.1994	-.068	-.83847	.70304	.4031
12 YDA	independent	.013562	.009021	.1134	.121	1.50336	2.26009	.1348
13 NOA	independent	-.003603	.005676	-.0796	-.052	-.63483	.40301	.5265
14 NWA	independent	.013513	.015183	.2149	.072	.89004	.79216	.3749
20 LDF	independent	.007736	.004658	.1094	.134	1.66091	2.75863	.0988
21 SDF	independent	.004217	.004989	.0664	.069	.84526	.71446	.3993
22 NDP	independent	-.009188	.016683	-.0574	-.045	-.55076	.30334	.5826
24 LFS	independent	-.009146	.015017	-.0432	-.050	-.60907	.37096	.5434

Standard Error of Estimate..... .0530
Multiple Correlation Coefficient..... .8755
Coefficient of Determination..... .7665
Corrected Coefficient of Determination.... .7417

ANALYSIS OF VARIANCE SUMMARY TABLE

Source of Variation	Sum of Squares	Deg. Freedom	Mean Square
Linear Regression	1.39045	16	.08690
Residuals from Regression	.42362	151	.00281
Corrected Total	1.81407	167	

F-Ratio = 30.98 with 16 and 151 Deg. Freedom
Significance Level of F-Ratio = .0000

Correction for Mean	6.74803	1	
Uncorrected Total	8.56210	168	

TABLE 52

PROPORTION OF VARIANCE ACCOUNTED
FOR BY THE FACTORS
MODEL 11

Factor Number	Percentage of Total Factor Variance	Percentage of Total Variance
1	37.8	31.7
2	13.0	10.9
3	12.4	10.4
4	9.9	8.3
5	7.7	6.4
6	7.6	6.3
7	7.1	6.0
8	3.1	2.6
9	1.5	1.2

TABLE 53

ROTATED FACTOR MATRIX
MODEL 11

Var./Factor		1	2	3	4	5	6	7	8	9
1	TDF	.131	-.094	.054	.792	-.052	.186	.254	-.013	.013
2	UDF	.014	.809	.089	.013	.007	-.075	.229	.118	-.138
3	TDS	.532	-.027	.024	-.223	-.184	.631	.318	.062	.046
4	UDS	.331	-.070	.138	-.068	.784	-.055	.121	.022	-.003
5	NDM	.906	-.015	.121	-.046	.302	.042	-.002	-.060	.042
6	YDM	.018	.818	-.030	-.063	-.077	.050	-.057	-.124	.125
7	NOM	.770	.457	.078	-.038	.287	.076	.065	-.025	-.149
8	NWM	.940	.021	.201	-.091	.100	.094	.140	.001	-.065
9	NDA	.729	-.087	.459	-.017	.128	.142	.185	.393	-.023
10	YDA	.186	.058	.834	-.015	.058	-.024	.101	.011	.022
11	NOA	.576	.066	.648	.139	.274	.218	.162	.102	-.076
12	NWA	.739	-.087	.392	.019	.058	.242	.184	.425	.011
13	LDF	.174	.157	.171	.139	.128	.127	.737	.038	.006
14	SDF	.530	.386	.210	.117	.274	.407	.040	.176	-.156
15	NDP	.760	.005	.131	.137	-.002	.351	.202	.006	.319
16	LFS	.199	-.048	.028	-.751	.007	.351	.107	-.024	.014

TABLE 54

BASIC REGRESSION STATISTICS
MODEL 11F

Variables in the Equation

Variable		Type	Regression Coefficient	Std. Error of Regression Coefficient	Standardized Regression Coefficient	Partial Correlation Coefficient	T-Value with 158 Deg. Freedom	Partial F Value with 1 and 158 Deg. Freedom	Sig. Level
25	DIFF	dependent							
		constant	-.195914	.039652		-.366	-4.94079	24.41144	.0000
9	NWM	independent	.042302	.010540	.3552	.304	4.01358	16.10886	.0001
7	YDM	independent	.046772	.006815	.3232	.479	6.86281	47.09810	.0000
12	YDA	independent	.005296	.006256	.0443	.067	.84659	.71672	.3985
2	TDF	independent	.005054	.002130	.1275	.185	2.37262	5.62934	.0189
5	UDS	independent	.006437	.001999	.1727	.248	3.22022	10.36984	.0016
4	TDS	independent	.006234	.002538	.1755	.192	2.45624	6.03309	.0151
20	LDF	independent	.016333	.003808	.2309	.323	4.28955	18.40025	.0000
14	NWA	independent	.010753	.005921	.1710	.143	1.81590	3.29749	.0713
22	NDP	independent	-.017465	.014028	-.1091	-.099	-1.24506	1.55018	.2150

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Standard Error of Estimate..... .0573
Multiple Correlation Coefficient..... .8452
Coefficient of Determination..... .7143
Corrected Coefficient of Determination.... .6980

ANALYSIS OF VARIANCE SUMMARY TABLE

Source of Variation	Sum of Squares	Deg. Freedom	Mean Square
Linear Regression	1.29580	9	.14398
Residuals from Regression	.51827	158	.00328
Corrected Total	1.81407	167	

F-Ratio = 43.89 with 9 and 158 Deg. Freedom
Significance Level of F-Ratio = .0000

Correction for Mean	6.74803	1	
Uncorrected Total	8.56210	168	

TABLE 55

COMPARISON OF MODELS

Full Model	Restricted Model	R^2 Diff.	Corr. R^2 Diff.
Model 11	Model 10	.0420	.0385
Model 1	Model 11	.0098	.0141
Model 4	Model 11	.0198	.0147
Model 7	Model 11	-.0052	.0011
Model 9	Model 11	.0166	.0168
Model 11	Model 11F	.0522	.0437
Model 1F	Model 11F	-.0090	.0056
Model 1FC	Model 11F	-.0571	.0493
Model 7F	Model 11F	-.0648	-.0638
Model 9F	Model 11F	.0196	.0207

TABLE 56

SUMMARY OF ONE-VARIABLE MODELS

Variable	R^2	Corrected R^2	F Ratio	df	Significance Level
ORD	.0060	.0000	1.00	1/166	.3198
TDF	.0498	.0441	8.71	1/166	.0036
UDF	.2073	.2026	43.42	1/166	.0000
TDS	.2920	.2878	68.48	1/166	.0000
UDS	.1513	.1462	29.59	1/166	.0000
NDM	.3858	.3821	104.25	1/166	.0000
YDM	.0767	.0712	13.79	1/166	.0000
NOM	.5123	.5094	174.38	1/166	.0000
NWM	.4841	.4810	155.77	1/166	.0000
TSM	.5254	.5225	183.77	1/166	.0000
NDA	.4100	.4065	115.37	1/166	.0000
YDA	.1323	.1271	25.31	1/166	.0000
NOA	.4511	.4529	139.22	1/166	.0000
NWA	.4160	.4125	118.24	1/166	.0000
TSA	.4715	.4683	148.07	1/166	.0000
OA	.4572	.4540	139.85	1/166	.0000
OM	.4871	.4840	157.62	1/166	.0000
DCA	.2647	.2603	59.77	1/166	.0000
DCM	.4349	.4315	127.77	1/166	.0000
LDF	.3125	.3084	75.46	1/166	.0000
SDF	.4698	.4666	147.07	1/166	.0000
NDP	.3922	.3886	107.12	1/166	.0000
SMD	.0090	.0030	1.51	1/166	.2209
LFS	.0303	.0245	5.19	1/166	.0240

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